DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEERING SUPPORT AGENCY

'5 APR 1991

MEMORANDUM FOR SEE DISTRIBUTION

FROM: HQ AFCESA/EN
139 Barnes Drive, Suite 1
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SUBJECT: Engineering Technical Letter (ETL) 94-01: Standard Airfield Pavement Marking Schemes - INFORMATION MEMORANDUM

1. PURPOSE. This ETL provides layout and dimensional criteria for airfield pavement markings and expedient airfield markings.

2. APPLICATION. This ETL applies to all USAF activities except those operating at municipal airports or jointly used airfields. In these cases, use Federal Aviation Administration (FAA) criteria described in FAA Advisory Circular 150/5340-l, Standards for Airport Markings.

2.1. Authority. AFPD 32-10, Air Force Installations and Facilities, and AFI 32-1042, Standards for Marking Airfields.

2.2. Effective Date. Immediately.

2.3. Ultimate Recipients. Airfield pavement marking designers for the US Air Force and the US Army.

2.4. Coordination. The marking schemes reflected within this ETL have been coordinated with the civil engineer and flying operations functional staff within the USAF's Major Commands (MAJCOMs), and the Air Force Flight Standards Agency's Instrument Flight Center and Air Traffic Services Center. They were also coordinated with the U.S. Coordinating Member for International Standardization.

3. REFERENCED PUBLICATIONS.

a. AFI 32-1042, Standards for Airfield Marking gives the specific requirements for marking USAF runways and taxiways.

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It also names the material specifications that can be used to obtain environmentally acceptable products for marking airfield pavements, and indicates who must accomplish the various tasks associated with this responsibility.

b. AFI 32-1044, Visual Air Navigation Systems gives information on lighted signs required for runway, taxiway and instrument hold positions, and aircraft arresting system locations. (Use AFR 88-14, Visual Air Navigation Facilities, as an interim source document.)

c. AFJMAN 32-1013, Airfield and Heliport Planning and Design Criteria, describes an airfield's imaginary surfaces, defining the protected airspace surrounding the airfield. (Use AFR 86-14, Airfield and Heliport Planning Criteria, as an interim source document.)

Federal Aviation Administration (FAA) Advisory Circular (AC) 70/7460-1, Obstruction Marking and Lighting.

e. FAA AC 150/5340-l, Standards for Airport Markings.

f. USAF Technical Order (TO) 36-l-3, Painting, Marking, and Lighting Requirements for USAF Vehicles.

4. DEFINITIONS. Not applicable.

5. SPECIFIC REQUIREMENTS. See Attachment 3.

6. POINT OF CONTACT. Mr Michael D. Ates, HQ AFCESA/DMPS, DSN 523-6351.

EDWARD E. WILSON, PE
Acting Director, Systems Engineering

Attachments:
1. Distribution List
2. ETL Index
3. Technical Details

ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
82-2	Energy Efficient Equipment	10 Nov 82
83-1	Design of Control Systems for HVAC	16 Feb 83
	Change No. 1 to ETL 83-1, U.S. Air Force Standardized Heating, Ventilating & Air Conditioning (HVAC) Control Systems	22 Jul 87
83-3	Interior Wiring Systems, AFM 88-l5, Para 7-3	2 Mar 83
83-4	EMCS Data Transmission Media (DTM) Considerations	3 Apr 83
83-7	Plumbing, AFM 88-8, Chapter 4	30 Aug 83
83-8	Use of Air-to-Air Unitary Heat Pumps	15 Sep 83
83-9	Insulation	14 Nov 83
84-2	Computer Energy Analysis	27 Mar 84
	Change 1 Ref: HQ USAF/LEEEU Msg 0316002 MAY 84	1 Jun 84
84-7	MCP Energy Conservation Investment Program (ECIP)	13 Jun 84
84-10	Air Force Building Construction and the Use of Termiticides	1 Aug 84
86-2	Energy Management and Control Systems (EMCS)	5 Feb 86
86-4	Paints and Protective Coatings	12 May 86
86-5	Fuels Use Criteria for Air Force Construction	22 May 86
86-8	Aqueous Film Forming Foam Waste Discharge Retention and Disposal	4 Jun 86
86-9	Lodging Facility Design Guide	4 Jun 86
86-10	Antiterrorism Planning and Design Guidance	13 Jun 86
86-14	Solar Applications	15 Oct 86
86-l 6	Direct Digital Control Heating, Ventilation, and Air Conditioning Systems	9 Dec 86
87-l	Lead Ban Requirements of Drinking Water	15 Jan 87
87-2	Volatile Organic Compounds	4 Mar 87
87-4	Energy Budget Figures (EBFs) for Facilities in the Military Construction Program	13 Mar 87
87-5	Utility Meters in New and Renovated Facilities	13 Jul 87
87-9	Prewiring	21 Oct 87
88-2	Photovoltaic Applications	21 Jan 88
88-3	Design Standards for Critical Facilities	15 Jun 88
88-4	Reliability & Maintainability (R&M). Design Checklist	24 Jun 88
88-6	Heat Distribution Systems Outside of Buildings	1 Aug 88
88-9	Radon Reduction in New Facility Construction	7 Oct 88

ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
88-I 0	Prewired Workstations Guide Specification	29 Dec 88
89-2	Standard Guidelines for Submission of Facility Operating and Maintenance Manuals	23 May 89
89-3	Facility Fire Protection Criteria for Electronic Equipment Installations	9 Jun 89
89-4	Systems Furniture Guide Specification	6 Jul 89
89-6	Power Conditioning and Continuation Interfacing Equipment (PCCIE) in the Military Construction Program (MCP)	7 Sep 89
89-7	Design of Air Force Courtrooms	29 Sep 89
90-I	Built-Up Roof (BUR) Repair/Replacement Guide Specification	23 Jan 90
90-2	General Policy for Prewired Workstations and Systems Furniture	26 Jan 90
90-3	TEMPEST Protection for Facilities Change 1 Ref: HQ USAF/LEEDE Ltr dated 20 April 90, Same Subject	23 Mar 90
90-4	1990 Energy Prices and Discount Factors for Life-Cycle Cost Analysis	24 May 90
90-5	Fuel and Lube Oil Bulk Storage Capacity for Emergency Generators	26 Jul 90
90-6	Electrical System Grounding, Static Grounding and Lightning Protection	3 Oct 90
90-7	Air Force Interior Design Policy	12 Oct 90
90-8	Guide Specifications for Ethylene Propylene Diene Monomer (EPDM) Roofing	17 Oct 90
90-9	Fire Protection Engineering Criteria for Aircraft Maintenance, Servicing, and Storage Facilities	2 Nov 90
90-I0	Commissioning of Heating, Ventilating, and Air Conditioning (HVAC) Systems Guide Specification	17 Oct 90
91-I	Fire Protection Engineering Criteria Testing Halon Fire Suppression Systems	2 Jan 91
91-2	High Altitude Electromagnetic Pulse (HEMP) Hardening in Facilities	4 Mar 91
91-4	Site Selection Criteria for Fire Protection Training Areas	14 Jun 91
91-5	Fire Protection Engineering Criteria - Emergency Lighting and Marking of Exits	18 Jun 91

ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
91-6	Cathodic Protection	3 Jul 91
91-7	Chlorofluorocarbon (CFC) Limitation in \Heating, Ventilating and Air-Conditioning (HVAC) Systems	21 Aug 91
93-l	Construction Signs	11 Mar 93
93-2	Dormitory Criteria for Humid Areas	13 Jul 93
93-3	Inventory, Screening, Prioritization, and Evaluation of Existing Buildings for Seismic Risk	18 Aug 93
93-4	Fire Protection Engineering Criteria - Automatic Sprinkler Systems in Military Family Housing (MFH)	11 Aug 93
93-5	Fire Protection Engineering Criteria - Electronic Equipment Installations	22 Dec 93
94-l	Standard Airfield Pavement Marking Schemes	5 Apr 94
94-2	Utility Meters in New and Renovated Facilities	10 Jun 94
94-3	Air Force Carpet Standard	10 Jun 94
94-4	Energy Usage Criteria for Facilities in the Military Construction Program	? Aug 94

ENGINEERING TECHNICAL LETTERS (ETL)

SECTION B - OBSOLETE ETLs

ETL Number	Date	Status
82-I	10 Nov 82	Superseded by ETLs 83-I0, 86-1, 87-4
82-3	10 Nov 82	Superseded by ETLs 83-5, 84-2
82-4	10 Nov 82	Superseded by ETL 84-7
82-5	10 Nov 82	Superseded by ETLs 84-1, 86-I3, 86-14
82-6	30 Dec 82	Cancelled
82-7	30 Nov 82	Cancelled
83-2	16 Feb 83	Superseded by ETL 84-3
83-5	5 May 83	Superseded by ETL 84-2
83-6	24 May 83	Cancelled
83-I0	28 Nov 83	Superseded by ETL 86-I
84-I	18 Jan 84	Superseded by ETL 86-14
84-3	21 Mar 84	Cancelled
84-4	IO Apr 84	Superseded by ETLs 86-7, 86-I5, 87-5
84-5	7 May 84	Superseded by ETLs 84-8, 86-I1, 86-I8, 88-6
84-6	Not Issued	Cancelled/Not Used
84-8	19 Jun 84	Superseded by ETL 86-I1
84-9	5 Jul 84	Superseded by ETL 88-7
88-5	2 Aug 88	Superseded by ETL 91-6
86-I	3 Feb 86	Superseded by ETL 87-7
86-3	21 Feb 86	Superseded by ETL 86-4
86-6	3 Jun 86	Superseded by ETLs 86-11, 86-I8, 88-6
86-7	3 Jun 86	Superseded by ETL 86-15
86-I1	3 Jul 86	Superseded by ETL 88-6
86-I2	3 Jul 86	Superseded by ETL 90-2
86-I3	18 Aug 86	Superseded by ETL 86-14
86-I5	13 Nov 86	Superseded by ETL 87-5
86-17	17 Dec 86	Superseded by ETL 89-6
86-I8	18 Dec 86	Superseded by ETL 88-6
87-3	12 Mar 87	Superseded by ETLs 87-6, ETL 88-5
87-6	21 Aug 87	Superseded by ETL-88-5
87-7	14 Oct 87	Superseded by ETL 89-I
87-8	19 Oct 87	Superseded by ETL 90-I
88-I	5 Jan 88	Superseded by ETL 89-2
88-5	2 Aug 88	Superseded by ETL 91-6
88-7	24 Aug 88	Superseded by ETLs 90-3, 91-2
88-8	4 Oct 88	Superseded by ETL 91-7
89-I	6 Feb 89	Superseded by ETL 90-4
89-5		'Issued as ETL 90-7
91-8	24 Sep 91	Cancelled
91-3	14 Jun 91	Superseded by MiL HDBK 1008B, Jan 94

CONSTRUCTION TECHNICAL LETTERS (CTL)

SECTION C - CURRENT CTLs

CTL Number	Title	Date Issued
88-2	DD Form 1354 Checklist	6 Jan 88
88-7	Constructibility Review Checklist	1 Nov 88
89-l	Thirty-Percent Design Submittal	lO Apr 89
89-2	MAJCOM Construction Management	30 May 89
89-3	Warranty and Guarantee Program	22 Sep 89
90-1	Management of the MILCON Planning and Execution Process	6 Mar 90
90-2	Definitions for Design Milestones	13 Mar 90

SECTION D - OBSOLETE CTLs

CTL Number	Status
87-l	Superseded by CTL 88-3
88-1	Superseded by CTL 90-l
88-3	Superseded by ETL
88-4	Replaced by Electronic Data File and Documentation in PDC/WIMS
88-5	Superseded by CTL 90-2
88-6	Issuance Cancelled

ETL 94-01, Technical Details for Standard Airfield Marking Schemes

1. General Information.

1.1. Purpose. This Engineering Technical Letter (ETL) gives layout and dimensional criteria needed to accomplish airfield pavement markings. Suggestions for improving this ETL should be sent directly to HQ AFCESA/DMPS with information copies to HQ AFCESA/EN, HQ AFSA/SEF, and AFFSA/XOI/XVR. MAJCOMs implementing tonedown markings, as described within NATO STANAG 3111 and ASCC Air Standard 65/31, should use the source documents for guidance.

1.2. Materials. The basic material applications are described below.

1.2.1. Permanent Markings. Use paint and retroreflective glass beads to apply runway markings. Use paint or preformed materials such as retroreflective marking tape, or thermoplastic and retroreflective glass beads to apply taxiway or helipad markings. Secondary taxiway and apron markings and overrun chevrons need not be reflectorized.

1.2.2. Temporary Markings: Mark paved or unpaved surfaces with lime and water solutions (whitewash) or preformed marking tape. Do not use preformed marking tape on runways. Exception: You may use tape to mark a temporarily displaced threshold if the area marked with tape will not be traversed by aircraft.

1.2.2.1. Where white markings do not provide the required contrast, such as for snow covered surfaces, a colored dye, such as sea-marker dye (yellow-green or yellow-orange), must be used.

1.2.2.2. Barricades or portable edge markers can be used instead of pavement markings during construction, or for expedient airfield marking. Use frangible markers designed and constructed of materials which will collapse if struck by an aircraft. They must be colored to present a sharp contrast with the surrounding terrain.

1.3. Application Rates. The best application rate for paints and preformed materials is variable depending on the intended purpose of the marking and the physical properties of the material. Some common applications are addressed below.

1.3.1. Paint. Apply paint at 0.305 to 0.356 mm (12 to 14 mils) wet film thickness for a desired dry film thickness of approximately 0.203 mm (eight mils). This is the thickness needed to properly bind retroreflective beads in the paint. At this rate, coverage will be approximately 2.970 m^2 per liter (121 square feet per gallon)..

1.3.1.1. Provide temporary marking on new pavement at an application rate of 0.102 to 0.152 mm (4 to 6 mils). This application rate will produce a marking of sufficient prominence to allow operations. Touch up the marking in the event of bleeding, and remark the pavement at the normal application rate after the pavement is 30 days old.

1.3.2. Thermoplastics and preformed reflective tape will be applied in accordance with the manufacturer's instructions.

1.3.3. Retroreflective media (glass beads) will be applied at approximately 3.6 to 3.9 kg per 11.24 m^2 (eight to nine pounds per gallon of paint, or 121 square feet) of marked surface area.

1.3.4. Painted markings should not be allowed to build up beyond approximately 1.02 mm (40 mils) total thickness. This will occur after about five marking cycles unless surface abrasion (such as can be caused by snow removal equipment) reduces this build up. Over-painting will eventually cause the marking to crack and peel.

1.3.5. Ensure no excessive buildup of paint occurs within 61 meters (200 feet) on either side of the aircraft arresting system pendant. This is necessary to minimize hook-skip potential.

1.4. Metric Dimension Conversions. All dimensions in this ETL are based on standards developed using the inch-pound system of measurement. Therefore, the dimensions provided in the layout schemes were calculated using the "soft" conversion method defined by the Metric Guide for Federal Construction, First Edition, published by the National Institute of Building Sciences, Washington DC. Since use of the "soft" metric units may be awkward within a contract specification, you may round all dimensions using the "hard" conversion method. To do this, round the metric dimension to the same number of digits as there were in the inch-pound dimension. For example, 72 feet X 0.3048 = 21.954 m, or 22 m.

2. Runway Markings.

2.1. There are three patterns for marking runways: basic, nonprecision instrument approach, and precision instrument approach. These are shown in figure 2.1.

2.2. Runway Centerline. Runway centerlines are marked with a series of uniformly spaced longitudinal stripes. They are 914 mm (3 feet) wide on non-precision instrument approach and precision instrument approach runways and at least 457 mm (I.5 feet) wide for basic runways. Begin layout of centerline markings 12.192 m (40 feet) inward from the runway numerals, and continue to the midpoint of the runway. Figure 2.2 gives the layout detail for centerline markings.

2.2.1. The 9 Sep 77 edition of AFR 88-16 promulgated threshold and designation markings which were longer than the current standard. Changing these markings to meet the new standard dimensions creates a gap 36.576 (120 feet) long between the new designation marking and the first existing centerline stripe. To fill this gap, you may mark an additional centerline stripe 12.192 m (40 feet) long between the designation marking and the first centerline stripe. In cases of parallel runways where a letter is added to the designation marking, the additional centerline stripe must be 21.336 m (70 feet) long. In either case the additional stripe is placed equidistant between the designation marking and the first existing centerline stripe. In this way, changes to the centerline stripe layout scheme may be deferred pending a new overlay or reconstruction project.

2.3. Threshold Marking. The threshold is the beginning of the full strength pavement. Thresholds are marked with a group of longitudinal stripes spaced symmetrically about the runway centerline. Figure 2.2 gives the layout detail for thresholds.

2.3.1. Displaced Thresholds. Mark displaced thresholds by repositioning the standard threshold marking at the new threshold. Place a transverse stripe on the pavement preceding the threshold. Extend the transverse stripe from edge stripe to edge stripe. The dimensions and layout details are shown in figure 2.3.

2.3.2. There are four different schemes which may be used to mark the pavement in the displaced area. Select a scheme from those shown in figure 2.4 which will suit the intended use of the area.

2.4. Runway Designation. Designation markings indicate the magnetic azimuth of the runway centerline to the nearest 10 degree increment. The designation consists of two numbers, or in the case of parallel runways, two numbers and a letter.

2.4.1. Numbers are formed with 762 mm (2.5,feet) wide vertical stripes and 1,524 mm (5 feet) wide horizontal stripes. All single-digit numbers are preceded by a zero. Lateral spacing between the numbers is 3,480 mm (10 feet) except for the numbers "10" and "ll." Spacing between numerals for these runway designations are 2,286 mm (7.5 feet) and 3,810 mm (12.5 feet), respectively. Typical layout is shown in figures 2.2 and 2.5.

2.4.2. For parallel runways, mark "L," "R," or "C" to represent left, right, or center runway (viewed from the approach) between the threshold (or threshold marking) and the designation marking. The longitudinal spacing between the threshold (or threshold marking) and the letter is 12.192 m (40 feet). Letters are 9.144 m (30 feet) long. The longitudinal spacing between the letter and the number is 12.192 m (40 feet). Letters are formed with 762 mm (2.5 feet)

wide vertical stripes and 1,524 mm (5 feet) wide horizontal stripes. Dimensions are given in figure 2.5.

2.5. Edge Stripes. Edge stripes must be marked on precision approach runways. Also mark them on runways where there is a lack of contrast between runway edges and shoulders or surrounding terrain.

2.5.1. The markings will consist of two continuous stripes placed symmetrically about the runway centerline. These stripes begin 12.192 m (40 feet) inward from the threshold marking and continue to within 12.192 m (40 feet) of the threshold marking on the opposite end of the runway. Where a displaced threshold exists, terminate the side stripe at the transverse threshold mark (with exception to temporary displaced threshold markings) and resume 914 mm (3 feet) from the repositioned standard threshold markings. The outer edge of the stripes may be positioned up to 914 mm (3 feet) inboard from the runway edge, but maintain a minimum separation of 42.672 m (140 feet) between the inner edges of the stripes on 45.720 m (150 feet) wide runways. The maximum separation between the inner edges of the stripes is 59.131 m (194 feet) on 60.960 m (200 feet) wide runways. Figure 2.2 shows the detail for edge stripes.

2.6. Touchdown Zone. These markings consist of pairs of longitudinal stripes placed symmetrically about centerline. Three stripes are provided in the first two pairs, two stripes in the next two pairs, and single stripes in the last two pairs. Lateral distance between each pair of longitudinal stripes measured at their inner edges is a constant 21.946 m (72 feet). Where any pair of markings fall within 304.800 m (1,000 feet) of the runway midpoint, omit them. Layout and dimensions are given in figure 2.6.

2.6.1. Fixed Distance Markings. Provide fixed distance markings on runways used by jet aircraft which are 45.720 m (150 feet) or wider and 1,219.200 m (4,000 feet) or longer. Substitute them in place of the second pair of touchdown zone markings. The layout plan and dimensions are given in figure 2.6.

2.7. Aircraft Arresting System Warning Markings. Mark aircraft arresting system locations on the runway with a series of discs located beneath the pendant. Where touchdown zone and disc markings coincide, the touchdown zone marking is interrupted at that location for a minimum distance of 305 mm (1 foot) from the edge of the disc marking. If the designation and disc markings coincide, shift the designation marking longitudinally to eliminate the conflict. The layout plan and dimensions for these markings are shown in figure 2.7.

2.8. Runway Overruns. Chevron markings are used on overruns to indicate the area is not an operational surface. The apex

of the initial chevron is located on the runway centerline at the beginning of the full-strength pavement. The legs of the chevrons intersect the centerline at a 45-degree angle. On runways greater than 45.720 m (150 feet) wide, the overrun marking may extend laterally beyond the runway threshold and edge stripe markings: however, do not extend them beyond the runway shoulder markings (deceptive surface markings). A typical layout plan and the dimensions for these markings are given in figure 2.8.

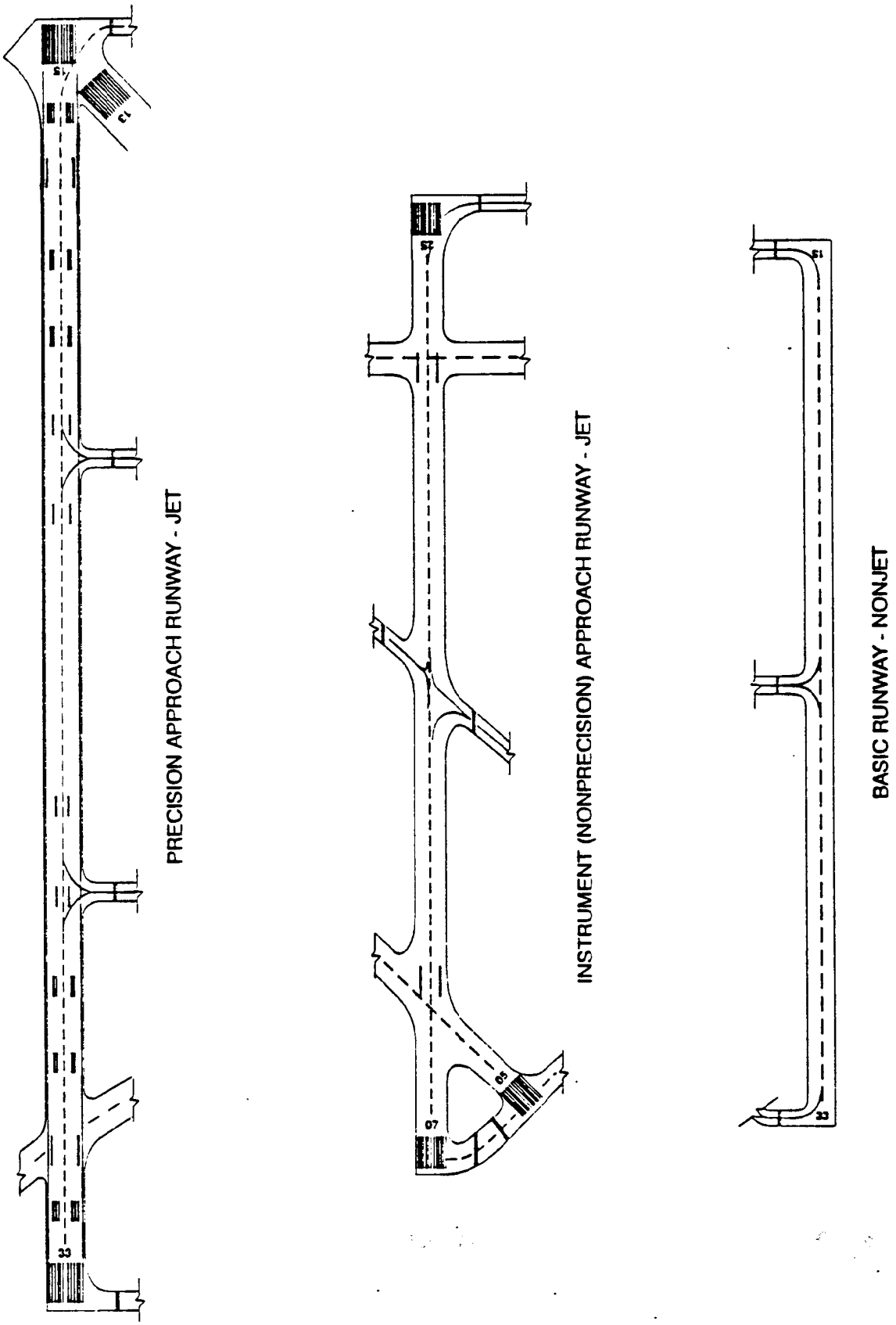
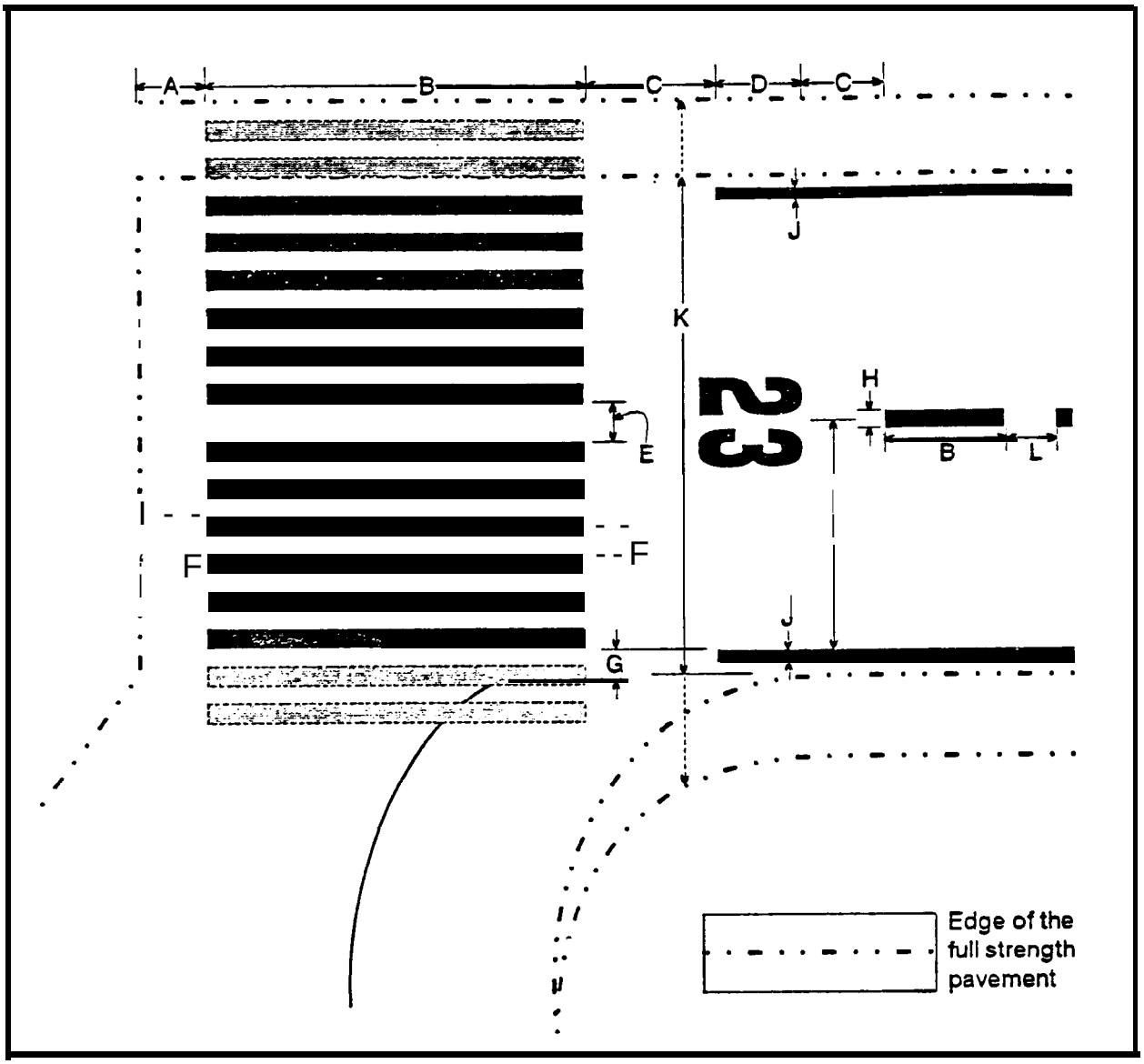
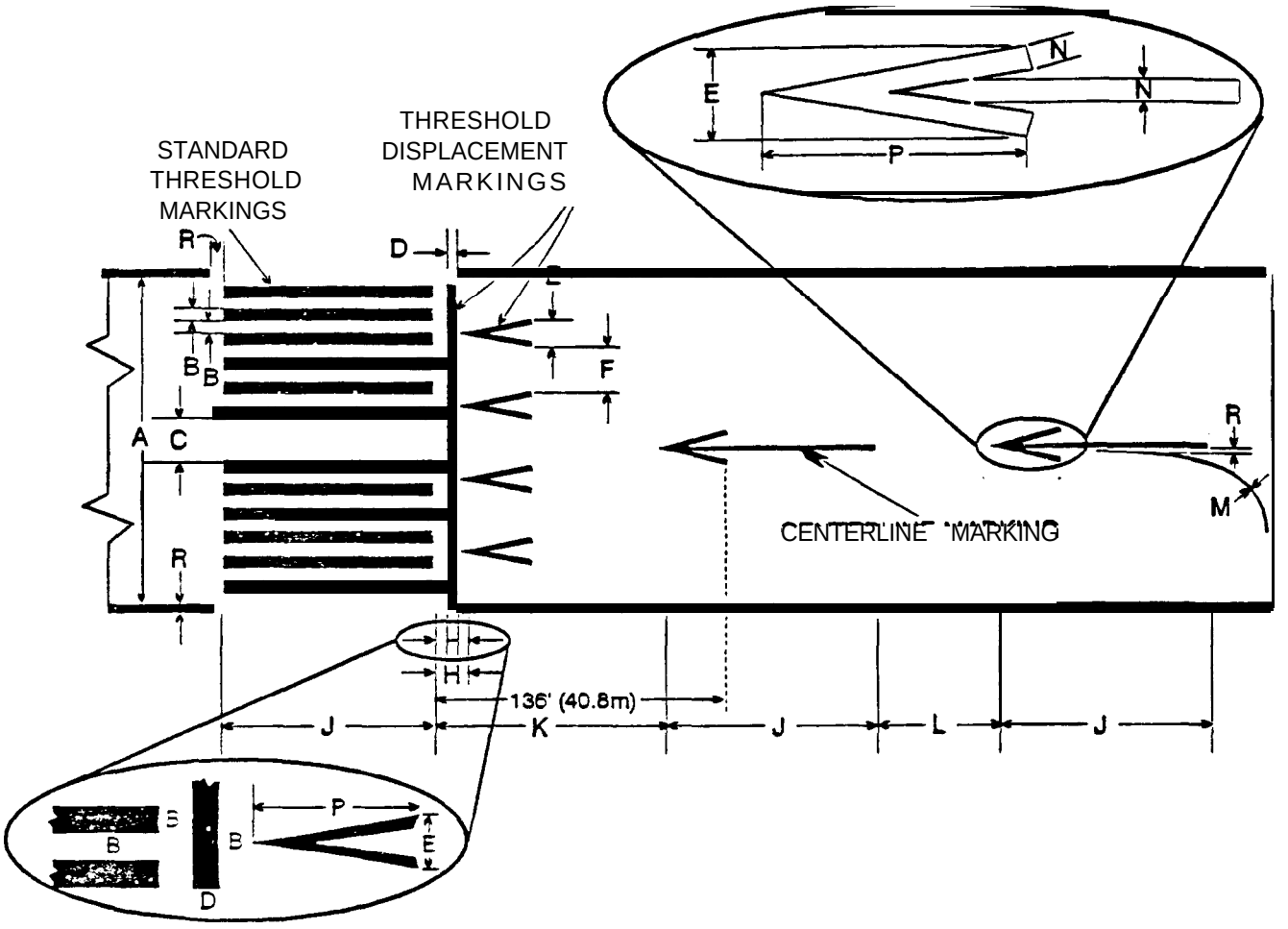


Figure 2.1. Runway Marking Schemes.



DIMENSION	METER	FEET
A	6.100	20.0
B	30.500	100.0
C	12.200	40.0
D	9.150	30.0
E	3.660	12.0
F	1.830	6.0
G	1.520	5.0
H	0.460 - 0.920	1.5 - 3.0
I	21.336	70.0
J	0.914	3.0
K	45.720 - 60.960	150 - 200
L	18.288	60.0

Figure 2.2. Threshold, Designation Number, Edge Stripe, and Centerline Layout.



DIMENSION	METERS	FEET
A	42.672	140.0
B	1.830	6.0
C	3.660	12.0
D	1.220	4.0
E	3.648	10.0
F	6.100	20.0
H	4.876	16.0
J	30.500	100.0
K	32.308	106.0
L	18.288	60.0
M	0.152	0.5
N	0.460 - 0.920	1.5 - 3.0
P	. 9.150	30.0
R	0.914	3.0

Figure 2.3. Typical Displaced Threshold Layout on 150 feet wide Runway.

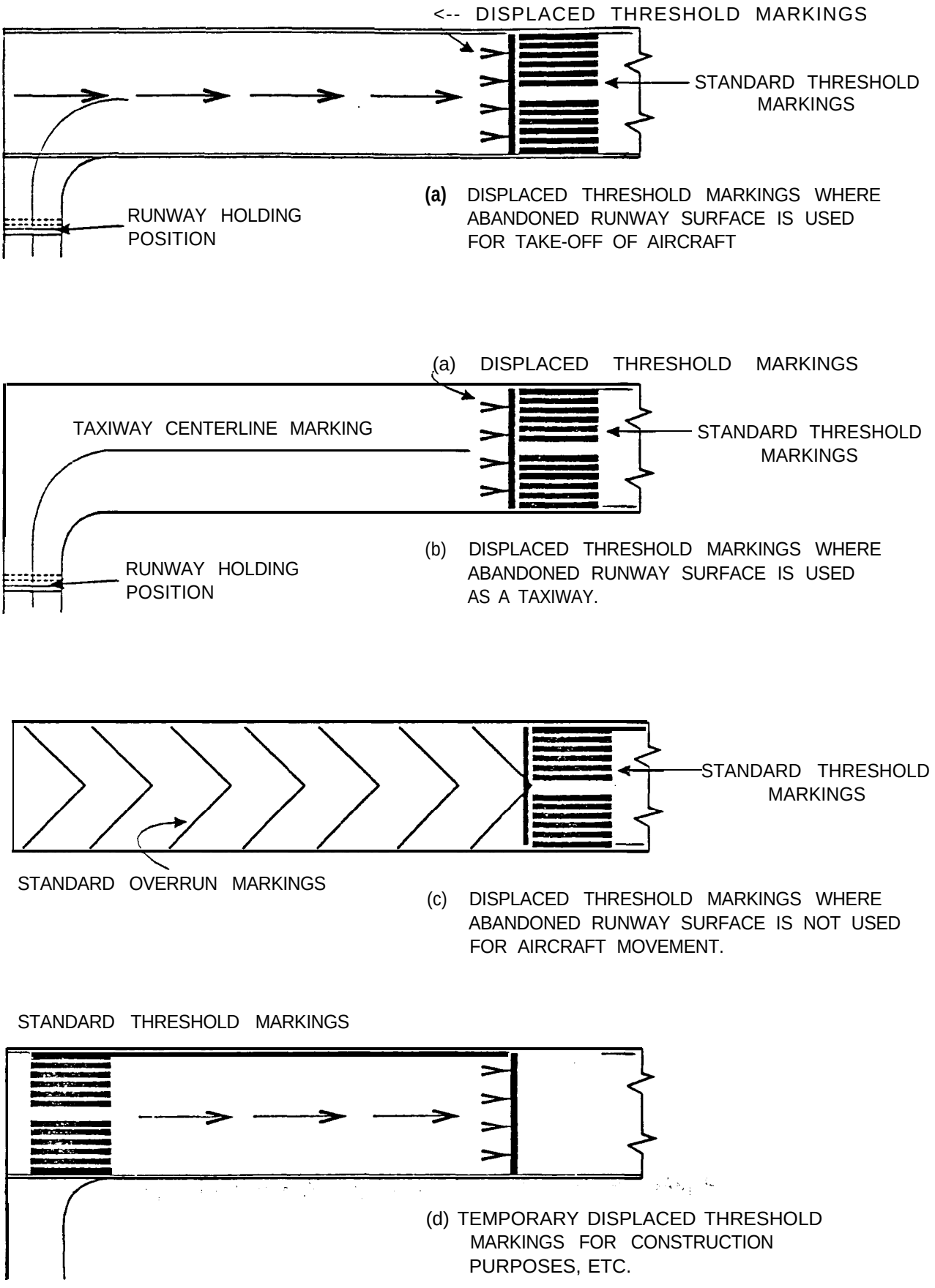
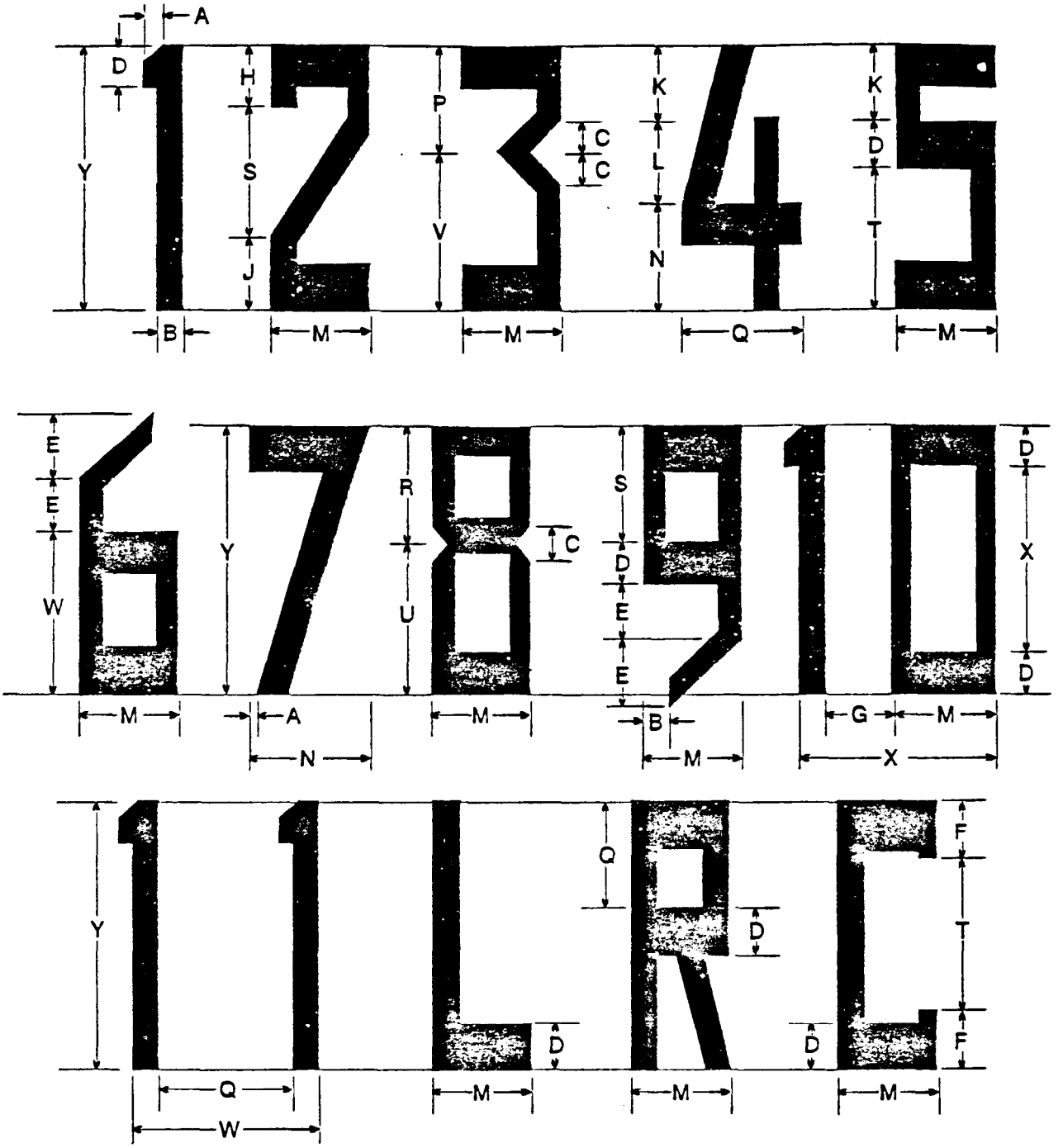


Figure 2.4. Displaced Threshold Area Marking Schemes.



DIMENSION	MILLI-METERS	FEET	DIMENSION	MILLI-METERS	FEET	DIMENSION	MILLI-METERS	FEET
A	305	1.0	J	2590	8.5	S	4115	13.5
B	762	2.5	K	2743	9.0	T	4877	16.0
C	1066	3.5	L	2896	9.5	U	5182	17.0
D	1524	5.0	M	3048	10.0	V	5486	18.0
E	1981	6.5	N	3505	11.5	W	5639	18.5
F	2134	7.0	P	3658	12.0	X	6096	20.0
G	2286	7.5	Q	3810	12.5	Y	9144	30.0
H	2438	8.0	R	3962	13.0			

Figure 2.5. Runway Designation Numbers and Letters.

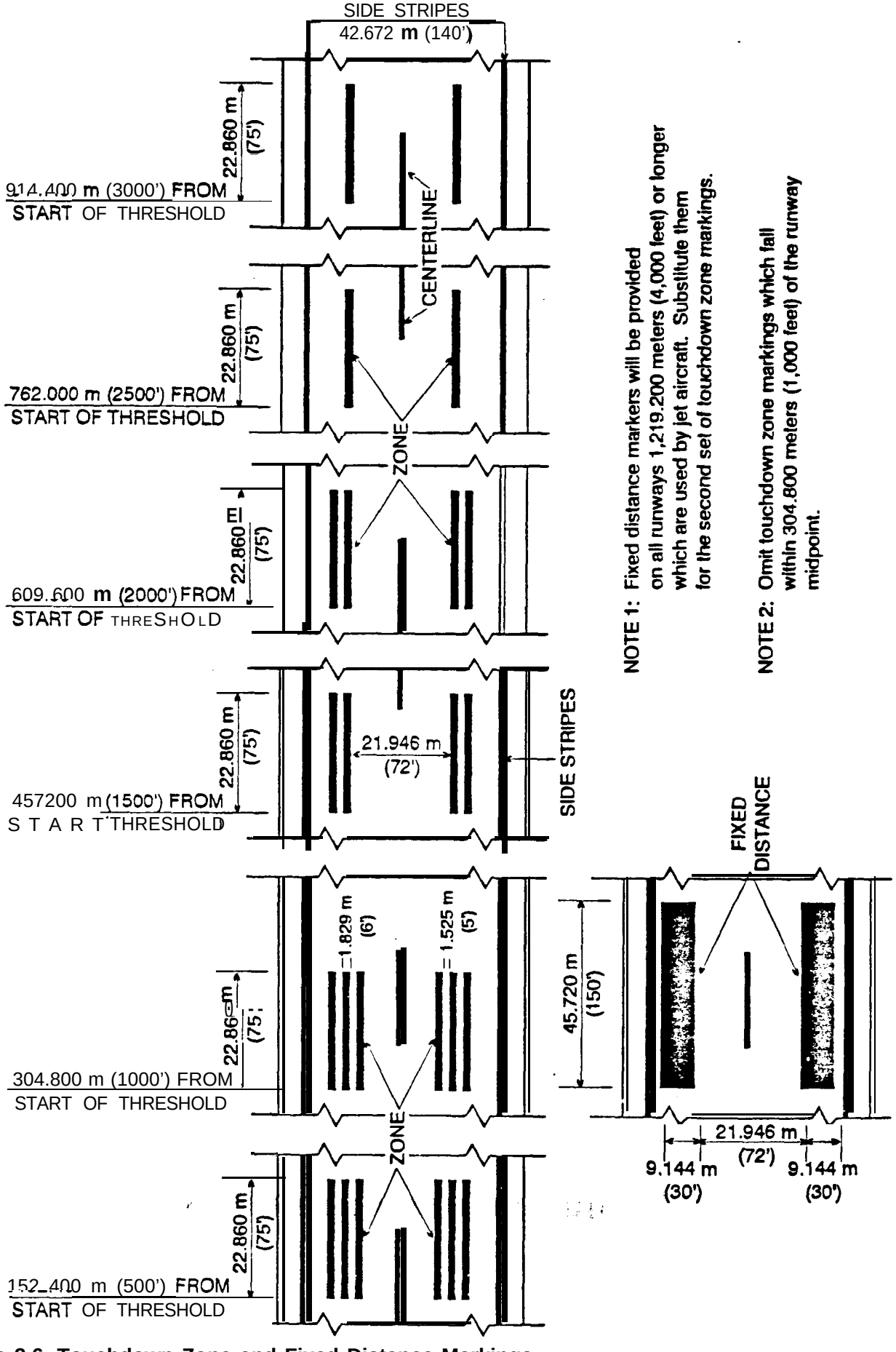


Figure 2.6. Touchdown Zone and Fixed Distance Markings,

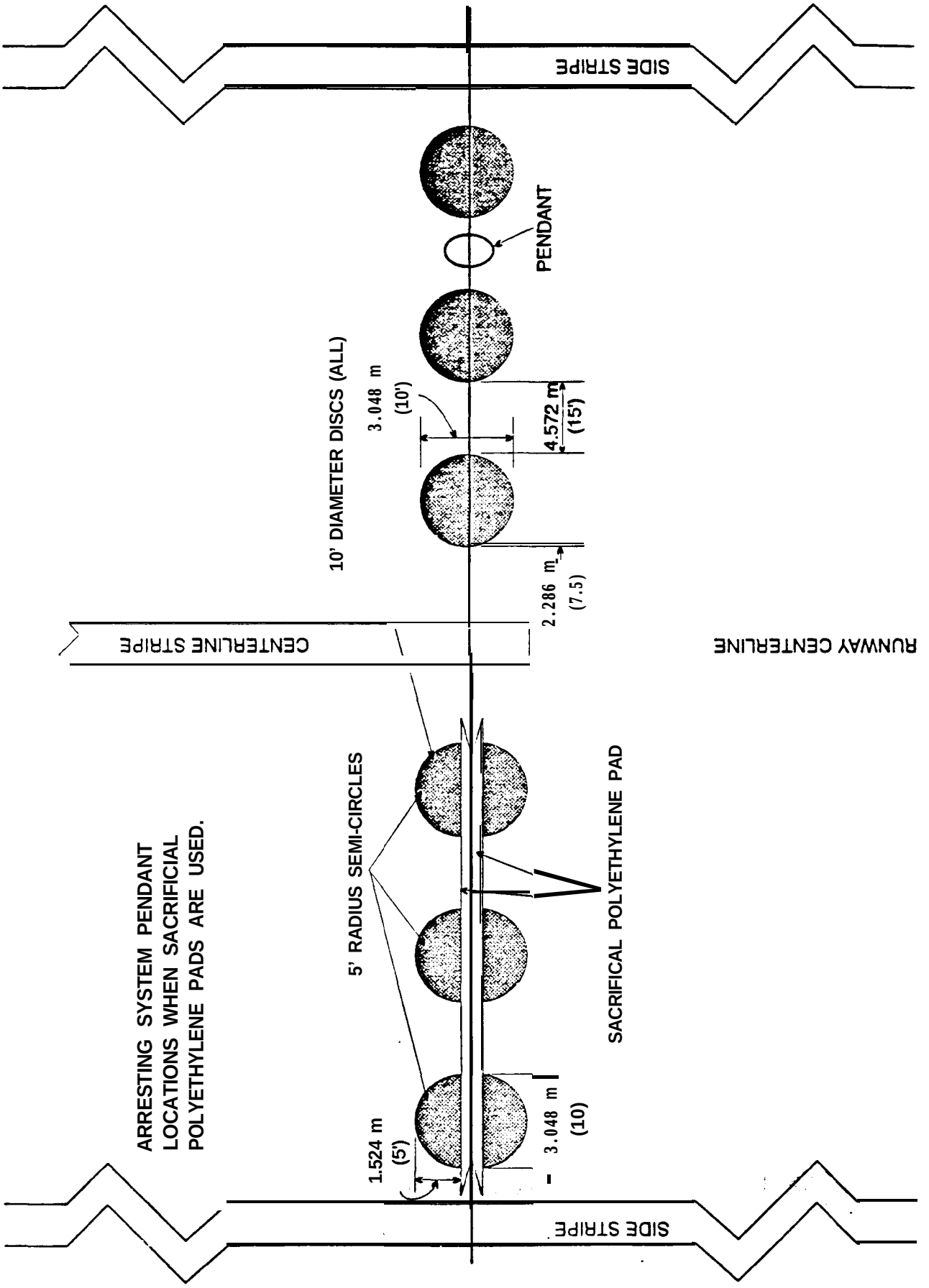


Figure 2.7. Aircraft Arresting System Warning Markings.

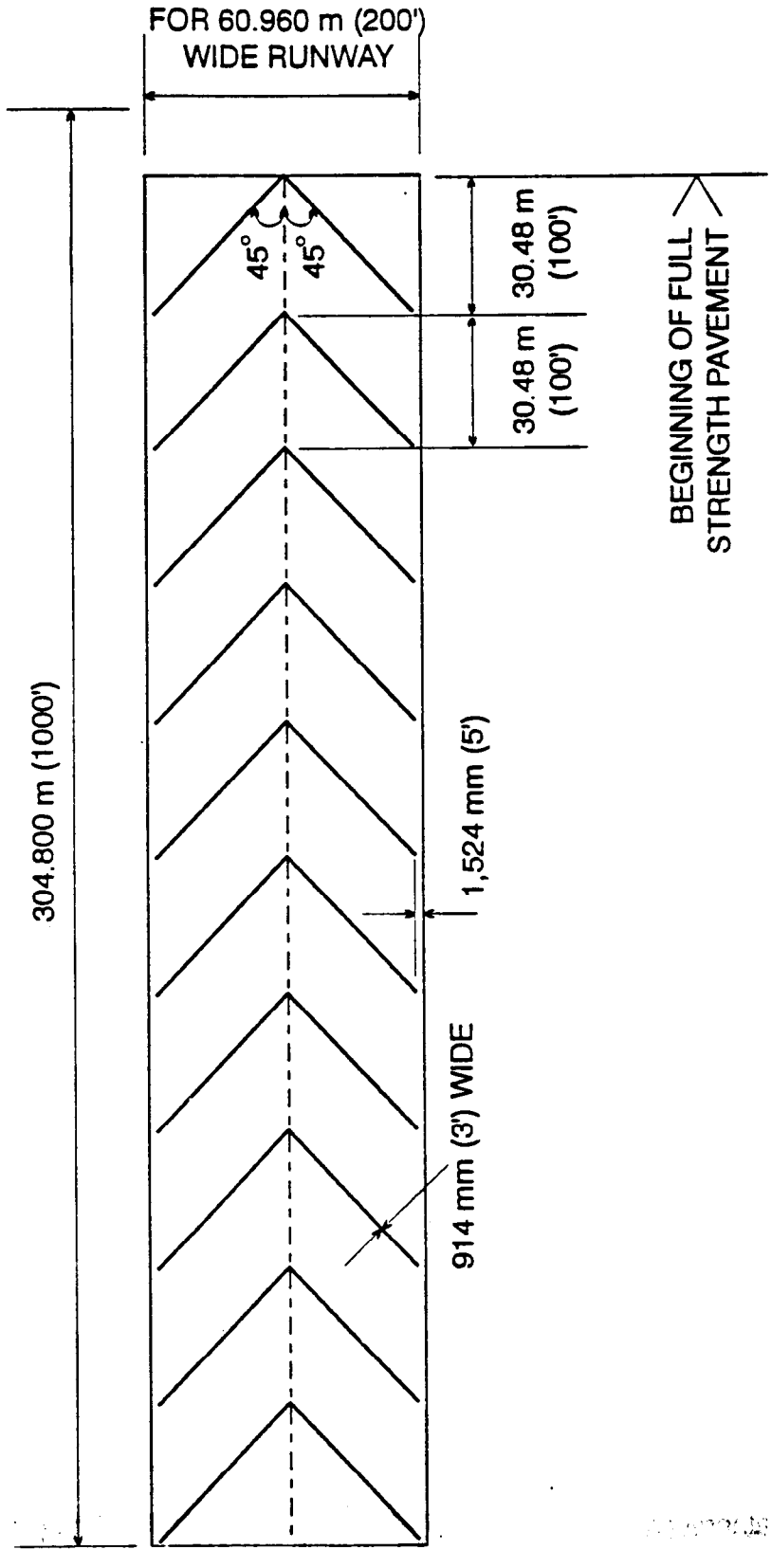


Figure 2.8, Runway Overrun Chevrons.

3. Taxiway and Apron Markings

3.1. Taxiway Centerline Stripe. Mark the centerline of all taxiways, guidelines on runways, and taxilanes on aprons and pads with a single 152 mm (6 inch) wide continuous stripe. All directional changes are accomplished with smooth curves. The radius selected is at least one-half the width of taxiway from edge of the full-strength pavement. On hammer-heads, aprons, and pads, the radius for the curve must be greater than the minimum turning radius for the assigned mission aircraft. The criteria needed to determine this radius can be found in Engineering Technical Letter (ETL) 1110-3-394, Aircraft Characteristics for Airfield-Heliport Design and Evaluation, 27 Sep 91. On runways, the curve is tangent to a line parallel to and 914 mm (3 feet) from the near side of the runway centerline marking. Typical taxiway and other nose-wheel guidelines are shown in figure 3.1.

3.2. Holding Positions. Holding positions are necessary on all pavements that lead to an active runway. They designate a boundary intended to protect the runway environment from incursions and prevent interference with signals transmitted by electronic navigational aids. There are two basic patterns for marking hold positions. One is used to mark hold positions used for visual flight rule (VFR) conditions, and the other is used to mark instrument (INST) hold positions. Figure 3.1 shows two ways to mark a VFR hold line and the layout for an instrument hold line. Both are marked from edge-to-edge of the operational pavement surface.

3.2.1. VFR Runway Holding Position. This holding position is located at least 30.480 m (100 feet) from the near edge of runway. This distance is measured perpendicular to the long axis of the runway. The hold position may be placed parallel to the runway centerline on taxiways which enter at an angle to the runway.

3.2.2. Instrument holding position. Runways served by precision instrument navigation aids will require an instrument holding position be marked in addition to the VFR holding position. It is located further from the active runway to prevent taxiing or holding aircraft from interfering with signals transmitted to inbound aircraft during instrument meteorological conditions. This hold position is configured differently from a VFR hold position and is augmented with the letters "INST" on the runway side of the line. The letters are to be read when facing the runway. They are marked in 1,829 mm (6 feet) high by 610 mm (2 feet) wide block letters, spaced 305 mm (1 foot) apart. The letters are formed with a 152 mm (6 inch) stroke. The "INST" designator must be placed symmetrically between the taxiway centerline and the taxiway edge or edge marking on the left side of the centerline. For hold lines over 60.960 m (200 feet) long, mark the "INST" designator at intervals not exceeding 45.720 m (150 feet). The

location for the instrument hold line varies, depending on the type and capability of the landing aid. Locate them in accordance with the following paragraphs.

3.2.2.1. Instrument holding position for a runway served by an Instrument Landing System (ILS). Ask your airfield manager, and if the height above touchdown (HAT) is 60.960 m (200 feet) or greater, mark the instrument holding position at the edge of the glide slope critical area. If the HAT is less than 60.960 m (200 feet), mark the holding position at the edge of the touchdown area or the glide slope critical area, whichever is farther from the edge of runway. The glide slope critical area and touchdown area are shown in figure 3.2. The instrument hold line must be at least 152.400 m (500 feet) from the runway centerline when the touchdown area criteria applies.

3.2.2.2. Instrument holding position for a runway served by Precision Approach Radar (PAR). Establish the instrument hold line at the edge of the touchdown area if the PAR serving that runway has a height above touchdown (HAT) less than 60.960 m (200 feet). If the HAT is greater than 60.960 m (200 feet), no instrument hold position is needed.

3.2.2.3. In all cases,' ensure a VFR hold position is marked between all instrument hold positions and the active runway. However, If either of the following examples apply, mark a VFR hold line only:

- If the runway hold line and the instrument hold line happen to fall at the same location, or;

- If the additional taxi time required to move from the instrument hold position to the runway is operationally acceptable under visual flight rules.

3.3. Taxiway and Apron Edge Stripes. When there is little contrast between the taxiway and the surrounding area, mark the edge of the full-strength pavement with two continuous 152 mm (6 inch) wide stripes separated by a 152 mm (6 inch) wide gap. This marking is used to delineate the edge of the taxiway or apron from other pavements or surfaces which are not intended for use by aircraft. It should never be used in areas where aircraft would be required to cross the designated boundary. Place this marking no more than 914 mm (3 feet) inward from the edge of the full-strength pavement. No portion of the marking should be placed on nonload-bearing pavements. Use the tangents for the taxiway centerline stripe on curves. In areas where this is not practical, use the edge of the full-strength pavement. Figure 3.1 shows a typical edge line layout, the width of the stripes, and the space between them.

3.3.1. Taxilane Edge Stripes. This marking is used to define the limits of a designated taxi route where the surrounding pavement is intended for use by aircraft. Movement of aircraft

across the designated boundary is permitted either by direction of Air Traffic Control, a marshaler, or at the pilot's discretion. This marking consists of two 152 mm (6 inch) wide broken stripes separated by a 152 mm (six inch) wide gap. The stripes are 4.572 m (15 feet) long with 7.620 m (25 feet) gaps. The detail and a typical layout are shown in figure 3.1.

3.4. Taxiway Identification. Taxiway identification signs are described within AFI 32-1044, Visual Air Navigation Facilities (use AFR 88-14 until it is published). Where it is desirable to furnish additional guidance at intersections, the information may be provided on the taxiway before the intersection. Runway and taxiway identification numbers and letters are marked in 1.828 m (6 feet) by 610 mm (2 feet) block letters formed with a 152 mm (6 inch) stroke. Provide an arrow above the identifier to show direction. Figure 3.3 shows typical identification numbers and letters.

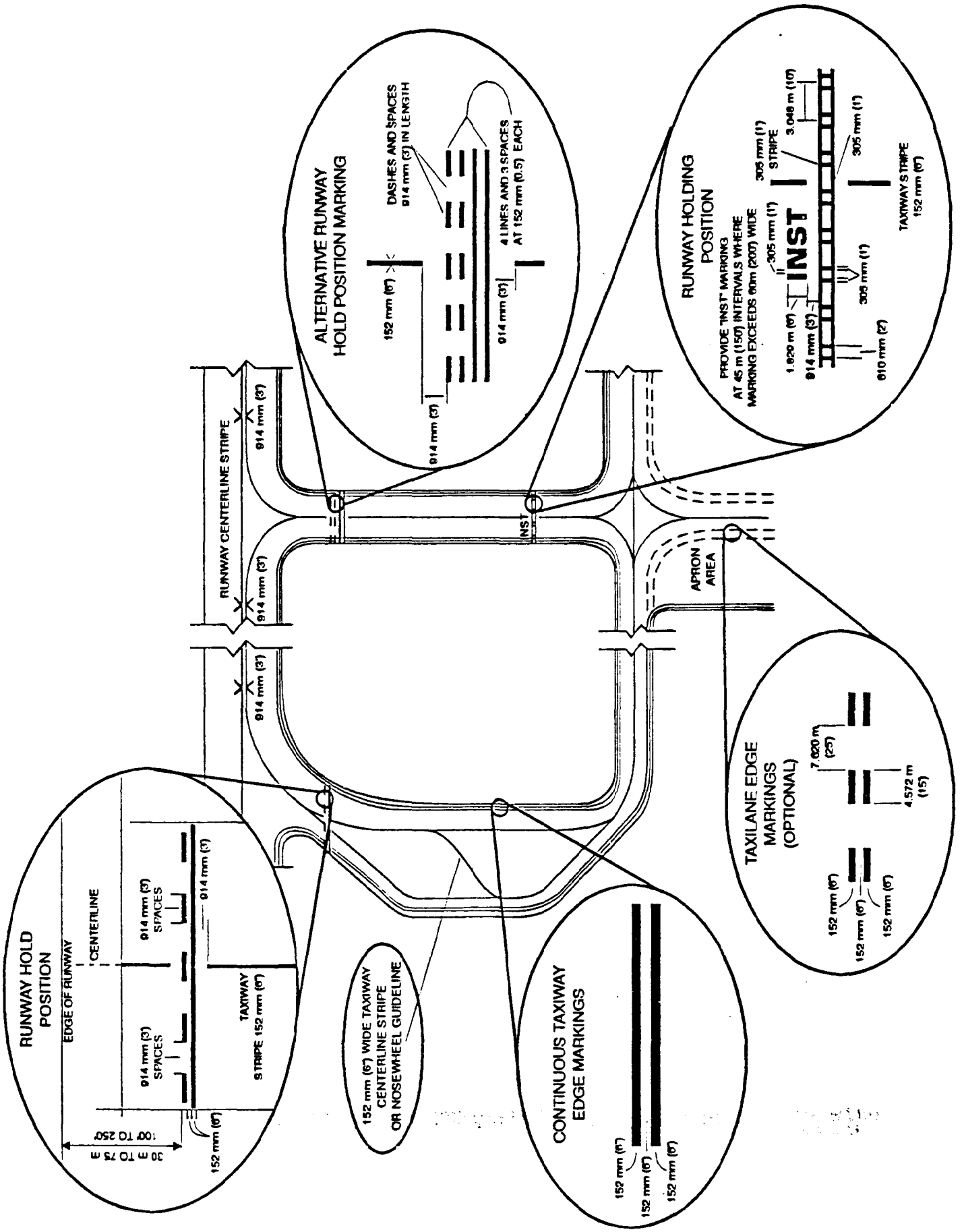
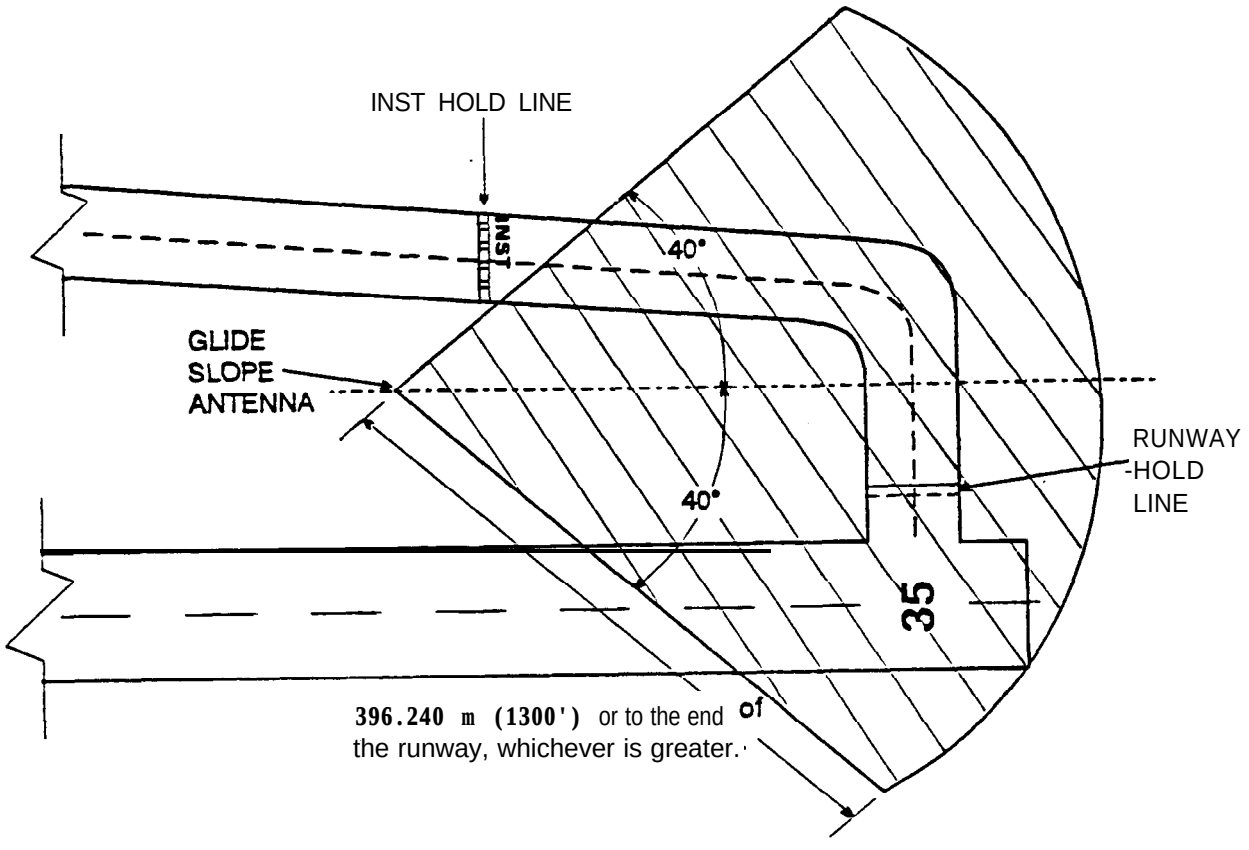


Figure 3.1. Taxiway Markings.



GLIDE SLOPE CRITICAL AREA

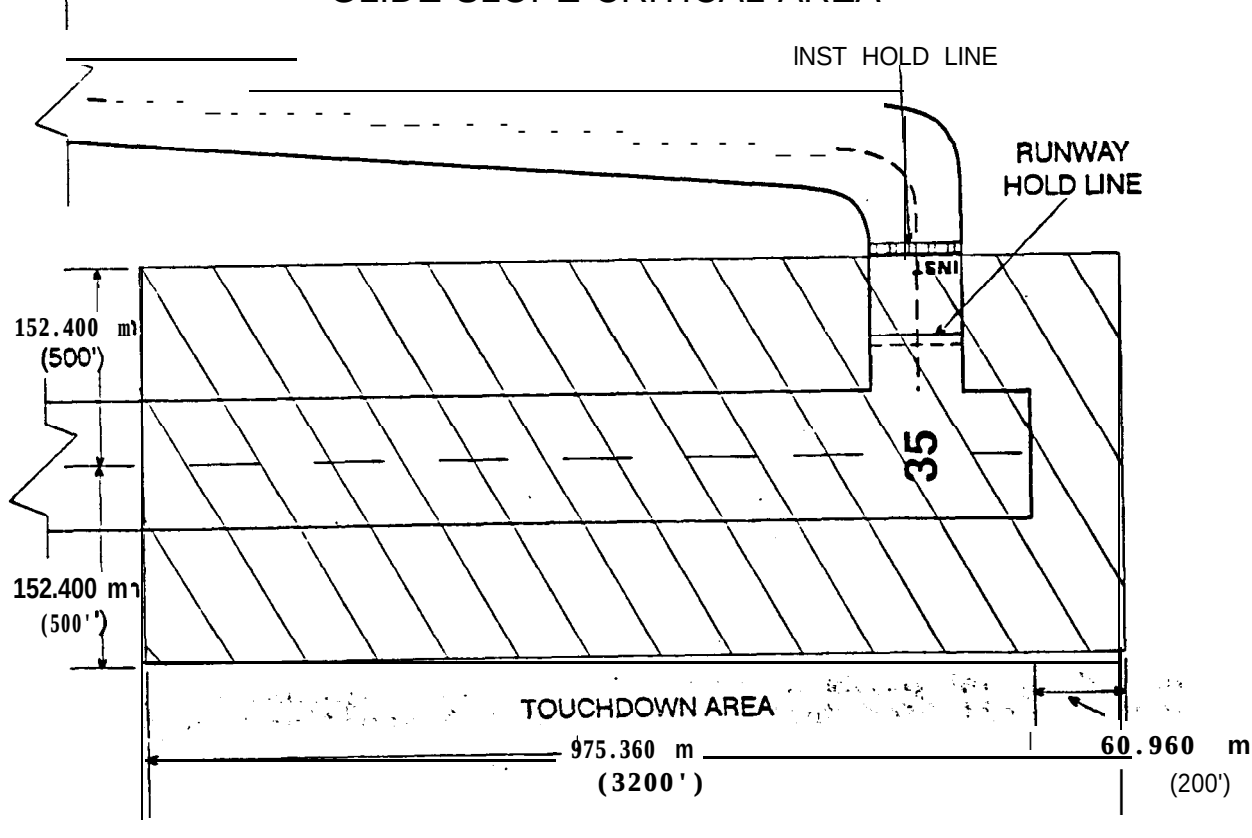


Figure 3.2. Locating Instrument Hold Line Positions.

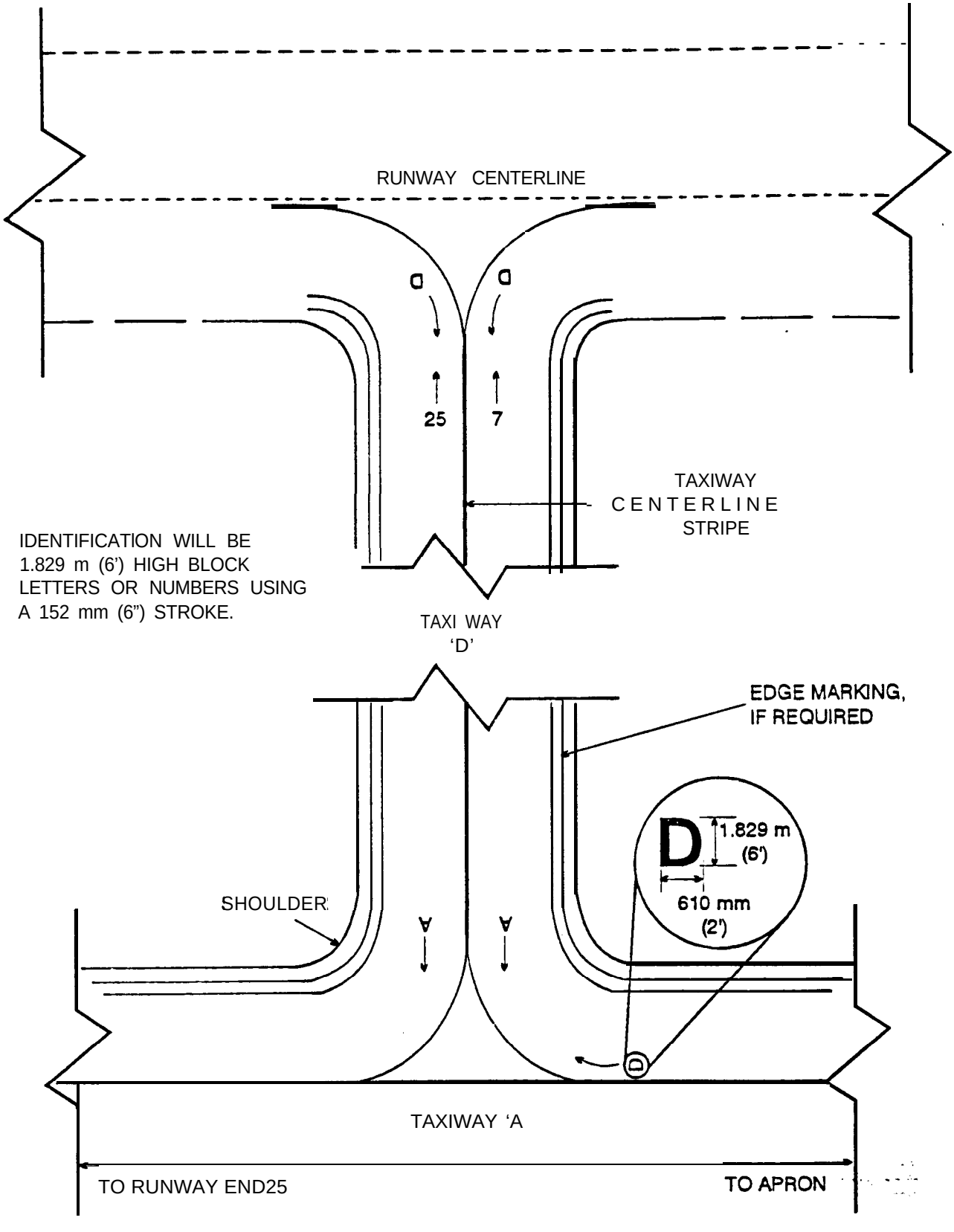
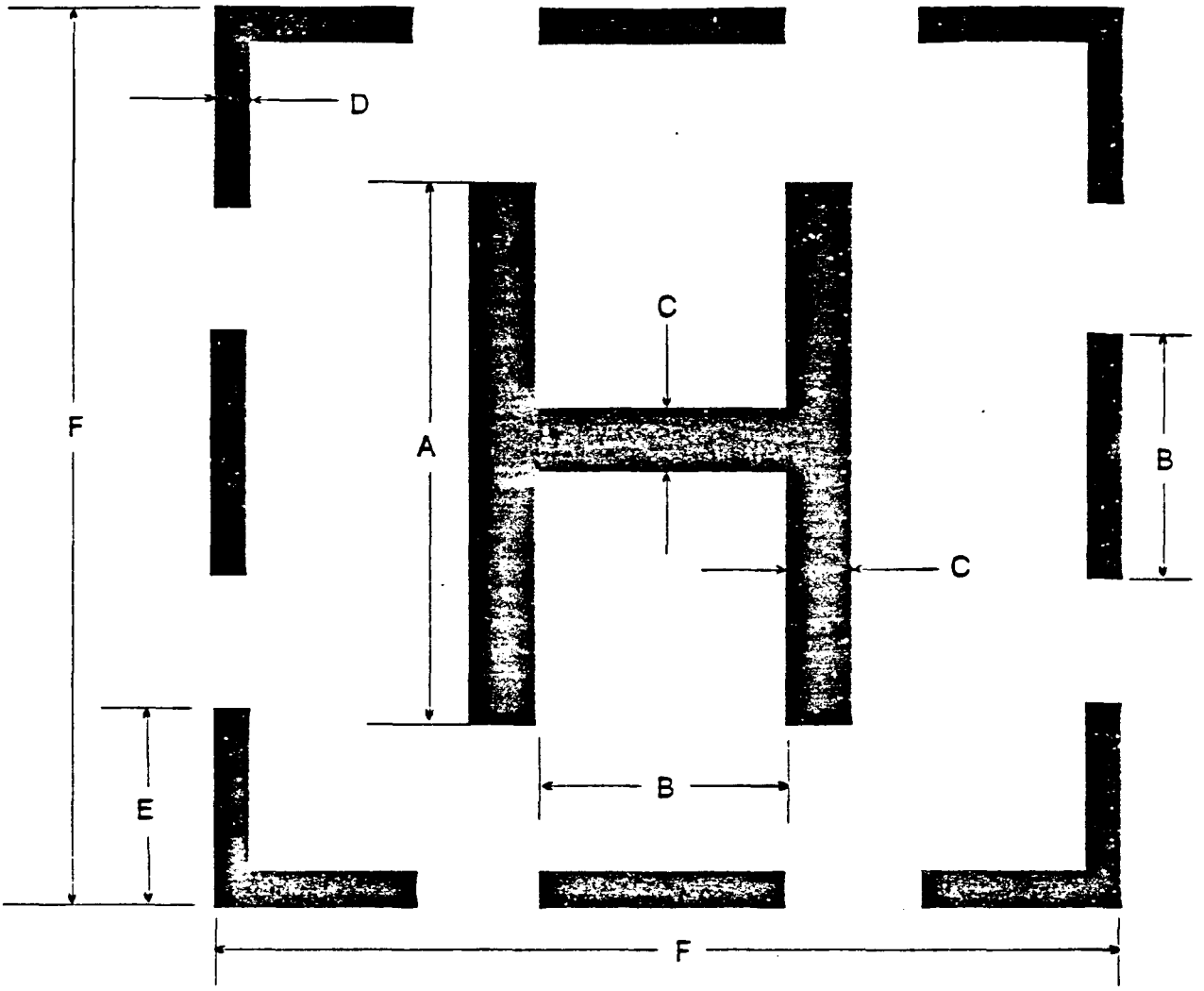


Figure 3.3. Taxiway and Runway Identifcation.

4. Helipads

4.1. Helipad Perimeter and Identification Markings. Mark a perimeter boundary with a capital "H" in the center to identify a pad intended for helicopter operations. (If the landing area is a runway, mark a capital "H" at the midpoint of the runway, centered on the pavement.) The perimeter boundary marking consists of a broken square marked at the corners and along the edges to delineate the limits of the safe touchdown area. The boundary must be sized to accommodate the overall length of largest helicopter using the facility. Figure 4.1 provides dimensions and layout details.

4.2. Hospital Helipad Markings. Medical facility helipads are marked similarly to standard helipads with the following exceptions. The perimeter border may be formed of a solid line and bordered in red, and the letter "H" is marked in red and is superimposed on a white cross. Figure 4.2 shows the dimensions and colors for this marking scheme.

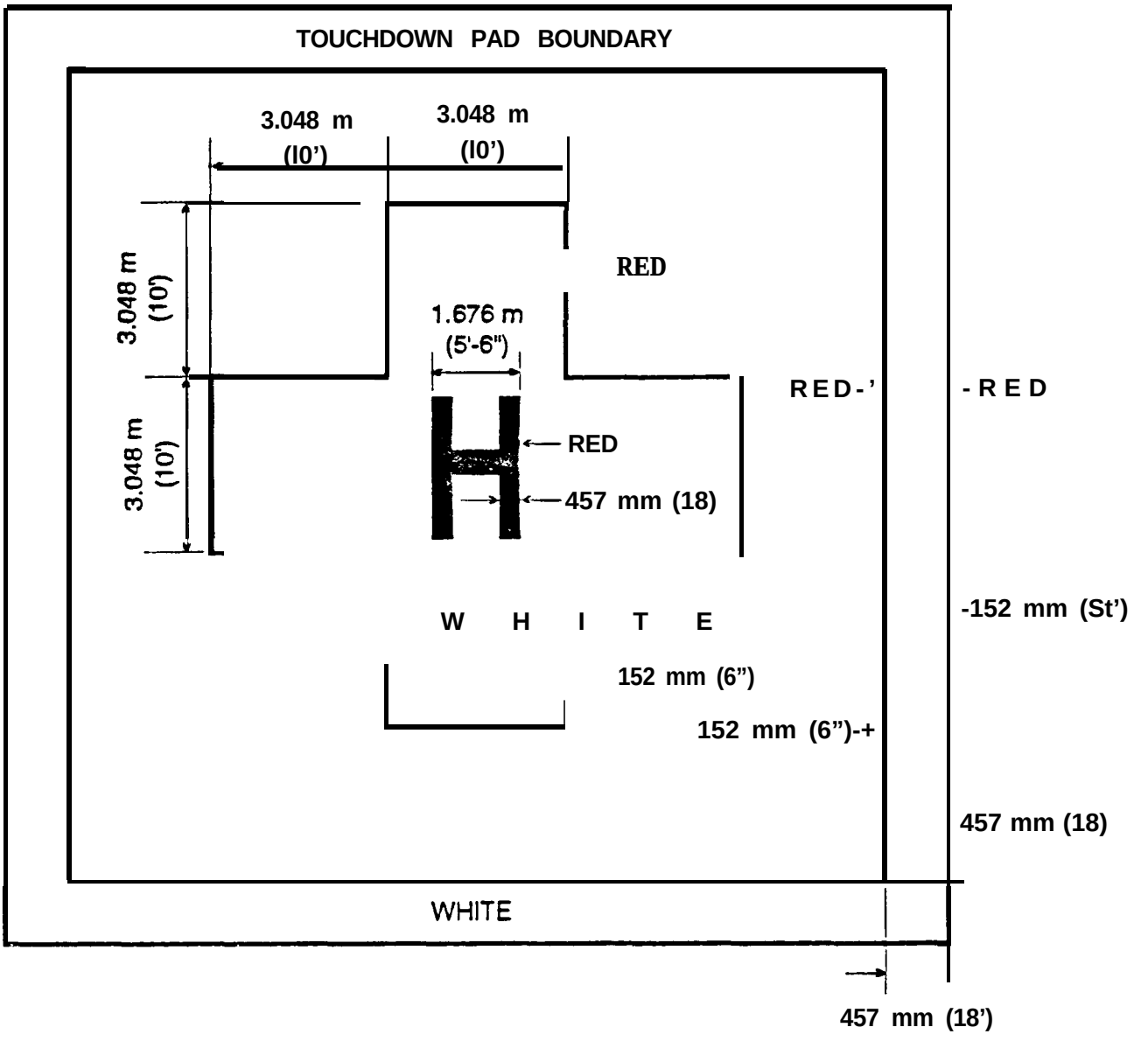


IDENTIFIER DIMENSIONS

DIMENSION A = .6 OF DIMENSION F (MAXIMUM OF 66 FEET)
DIMENSION B = .5 OF DIMENSION A

	HELIPAD SIZE (F)	PATTERN LINE WIDTH (C)	BORDER EDGE WIDTH (D)	CORNER EDGE LENGTH (E)
METERS	13 m TO 18 m	914 mm	396 mm	1.524 m
FEET	43' TO 59'	3'	1.3'	5'
METERS	18 m TO 24 m	1.219 m	610 mm	2.134 m
FEET	60' TO 79'	4'	2'	7'
METERS	24 m TO 30 m	1.524 m	610 mm	3.048 m
FEET	80' TO 98'	5'	2'	10'
METERS	30 m OR LARGER	1.981 m	762 mm	3.505 m
FEET	99' OR LARGER	6.5'	2.5'	11.5'

Figure 4.1. Helipad Perimeter and Identification Markings.



CROSS AND PAD BOUNDARY MARKINGS ARE WHITE AND MAY BE OUTLINED WITH A 152 mm (6") WIDE RED BORDER TO IMPROVE CONTRAST.

PAD BOUNDARY MARKINGS MAY BE EITHER A SOLID OR SEGMENTED LINE.

Figure 4.2. Hospital Helipad Markings.

5. Other Pavement Markings.

5.1. Closed Pavement Markings. Pavements that are hazardous to aircraft traffic are marked with capital "X"s. Refer to figure 5.1 for the dimensions and layout details. The following paragraphs describe placement of these markings and alternatives for temporarily closed areas.

5.1.2. Permanently Closed Runways. Obliterate the designation numbers on both ends of the runway and mark an "X" in place of the numbers. An "X" is also placed on the runway centerline at evenly spaced intervals not exceeding 304.800 m (1,000 feet). Where operational pavements cross a closed runway, place an "X" on the closed runway adjacent to both edges of the serviceable pavement and obliterate any runway markings which conflict with the serviceable pavement. Figure 5.2 shows typical placement of these markings.

5.1.3. Permanently Closed Taxiways. Obliterate the centerline stripe and mark the taxiway with a "X" at every junction with a serviceable pavement. Refer to figure 5.1 for the dimensions and layout details and figure 5.2 for typical placement. Additionally, obliterate all extraneous taxiway markings from the adjacent serviceable pavements. For example, remove or hide any line delineating a route from an active runway to a closed taxiway.

5.1.4. Temporarily Closed Runways. When temporarily closing a runway, the "X" may be fabricated of plywood, canvas, painted picket fence sections, preformed marking tape, or other materials. It can be anchored by any suitable means, such as with nails or sandbags. Another alternative is use of lighted "X"s as described in Federal Aviation Administration Advisory Circular 150/5340-l. Place an "X" at both ends of the runway on top of the runway designation number. For this purpose, the dimensions of the "X" shown in figure 5.1 may be reduced to allow use of standard 1,219 mm by 2,438 mm (4- by- 8 foot) sheets of plywood.

5.1.5. Temporarily Closed Taxiways. Use materials described in paragraph 5.1.3 to construct and fasten markers to the pavement. Ensure an "X" is placed at all access points to the closed pavement. In this case, it is not necessary to obliterate the existing taxiway markings, but it may be desirable to use lighted barricades to ensure the area is adequately marked. See paragraph 5.2 and figure 5.3.

5.1.6. Closed Aprons. When an apron is closed on an active airfield, taxilanes and taxiways leading to the closed area are marked as closed taxiways. If the closed apron area adjoins an active apron, supplemental markings are needed to indicate division between the two areas.- The separation is marked with two continuous taxiway edge stripes as described in paragraph 3.3 and shown in figure 3.1. The letter "X" as described above is marked three feet (914 nun) inward toward the closed apron

at intervals not exceeding 60.960 m (200 feet) on the closed apron sides. Figure 5.2 shows the dimensions and typical layout for these markings.

5.2. Barricades. Where pavement markings do not provide adequate definition of closed or hazardous areas, use reflective orange and white colored barricades with amber-yellow lights. All barricades must be anchored or be of sufficient mass to retain an established position where they are placed. Flashing lights must be at least five candelas effective intensity and flash at a rate of from 55 to 75 flashes per minute. Continuous burning lights must have an effective intensity of 10 candelas. Examples are shown in figure 5.3.

5.2.1. Place barricades at 15.240 m (50 feet) minimum intervals and use dual markers and lights on corners and ends.

5.3. Shoulder Markings (Deceptive Surfaces). Shoulders and other areas of airfield pavements that are not intended for aircraft traffic but have the appearance of operational pavement may need to be marked as deceptive surfaces. Use deceptive surface markings when the expanse of stabilized area is larger than the standard dimension or if experience shows that edge stripes do not provide adequate definition of the full-strength pavement.

5.3.1. Runway shoulders. Mark deceptive surfaces on the edges of runways with diagonal stripes as shown in figure 5.4. The stripes are laid out uniformly from each end of runway to the midpoint. Begin the measurement for spacing at the initial overrun chevron apex. The ends of the stripes align longitudinally with the ends of the overrun chevrons.

5.3.2. Taxiway and Apron Shoulders. Mark deceptive surfaces on the edges of taxiways and aprons with perpendicular stripes as shown in figure 5.5. These markings consist of a series of 914 mm (3 feet) wide stripes positioned perpendicular to the edge markings. On curves, a stripe is placed at each point of tangency and intermediate stripes are spaced uniformly up to 15.240 m (30 feet) apart. Figure 5.5 shows the dimensions and spacing of the stripes. Stripes are located so that the inner edge of the marking is coincident with the edge of the full-strength pavement.

5.4. Vehicular Access Marking. Mark vehicular access routes according to the US Department of Transportation's Manual on Uniform Traffic Control Devices for Streets and Highways. This manual, stock number 5001-0021, is available from the Superintendent of Documents, US Government Printing Office, Wash DC 20402. Additionally, all vehicular access roads leading to runways must be marked with, a white "stop" bar at the normal positions for VFR or instrument hold lines. See paragraph 3.2.

5.5. Inertial Navigation System (INS) Checkpoint Markings. INS checkpoint markings are provided to allow data input or calibration of the aircraft inertial navigation system. White contrasting colors are used for the border, numerals, and letters on dark-colored pavements, and black contrasting colors are used on light-colored pavements. A record of actual coordinates should be maintained by base operations flight data, transient alert, and maintenance control. Figure 5.6 show6 a typical layout scheme. Suggested locations are:

Nose wheel parking spots on aprons and ramps.

Engine run up areas adjacent to runway ends.

Hammerheads.

Taxiway and apron holding position lines.

NOTE: Survey support for navigational aid6 (NAVAIDs) and INS checkpoints should be coordinated with base and MAJCOM Mapping, Charting, and Geodesy offices, according to AFI 14-205, Identifying Requirements for Obtaining and Using Cartographic and Geodetic Products and Services.

5.6. Ground Receiver Checkpoint Markings. Identify instrument navigation checkpoint markings such as VHF Omni Range (VOR) and Tactical Air Navigation (TACAN) markings as are shown at figure 5.7. Where directional alignment of the aircraft is required, paint a 152 mm (6-inch) wide line through the center of the circle which extends outside the circle aligned toward the transmitter. Terminate the line with an arrowhead. Black or white paint may be used to contrast this marking as required. Also ensure that a sign is placed as close as possible, and perpendicular to, an imaginary line formed as an extension of the arrow. The sign must not interfere with aircraft operations. The sign should be mounted 508 mm to 762 mm (20 to 30 inches) above ground and lettered large enough to be read easily from the checkpoint. It shall display the facility identification, frequency, both course settings (i.e., 180/360), and distance measuring equipment (DME) distance, when available.

NOTE: Survey support for navigational aids (NAVAIDs) and INS points should be coordinated with base and or MAJCOM Mapping, Charting, and Geodesy offices, according to AFI 14-205, Identifying Requirements for Obtaining and Using Cartographic and Geodetic Products and Services.

5.7. Compass Calibration Pads. Compass calibration pad markings vary depending upon the type aircraft serviced. Aircraft Navigation System and Magnetic Compass Calibrator Technical Orders provide specific detail6 for design, location, construction, and marking of these locations. If aircraft are serviced which do not require a specific marking, general guidelines for Types I, II and III compass calibration pads are

provided in Federal Aviation Administration (FM) Advisory Circular (AC) 150/5300-13. Bases can obtain a current copy of these instructions from HQ AFCESA/DMP, 139 Barnes Drive, Suite 1, Tyndall AFB FL 32403-5319.

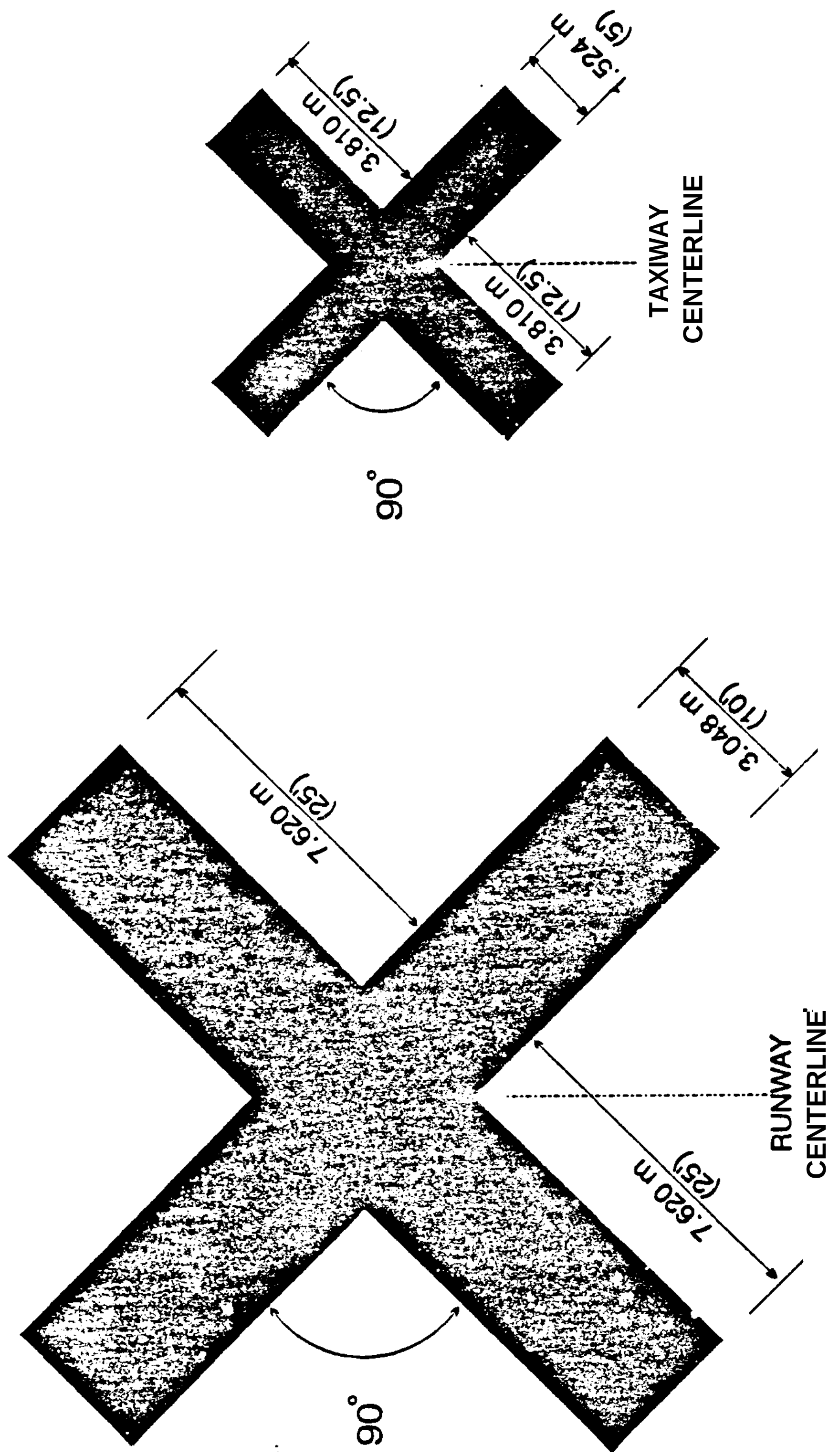


Figure 5.1. Closed Pavement Marking Dimensions.

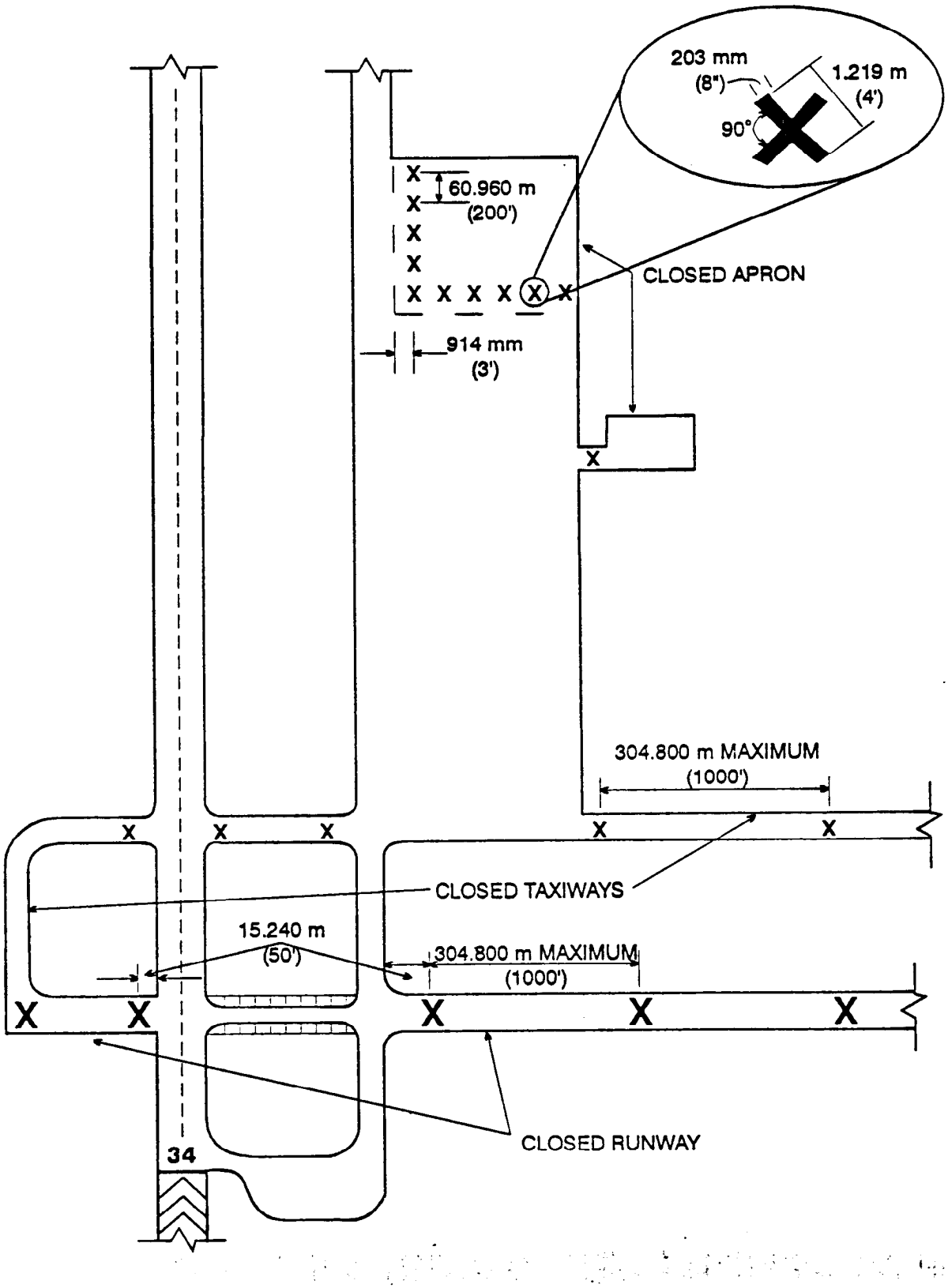
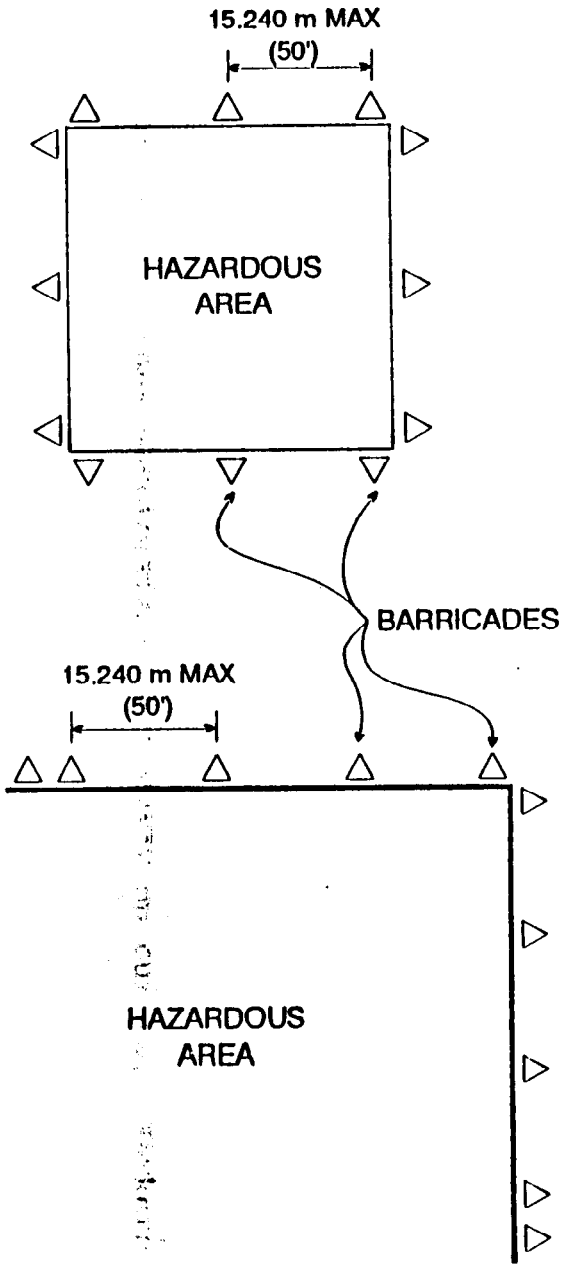


Figure 5.2. Placement of Closed Pavement Markings.



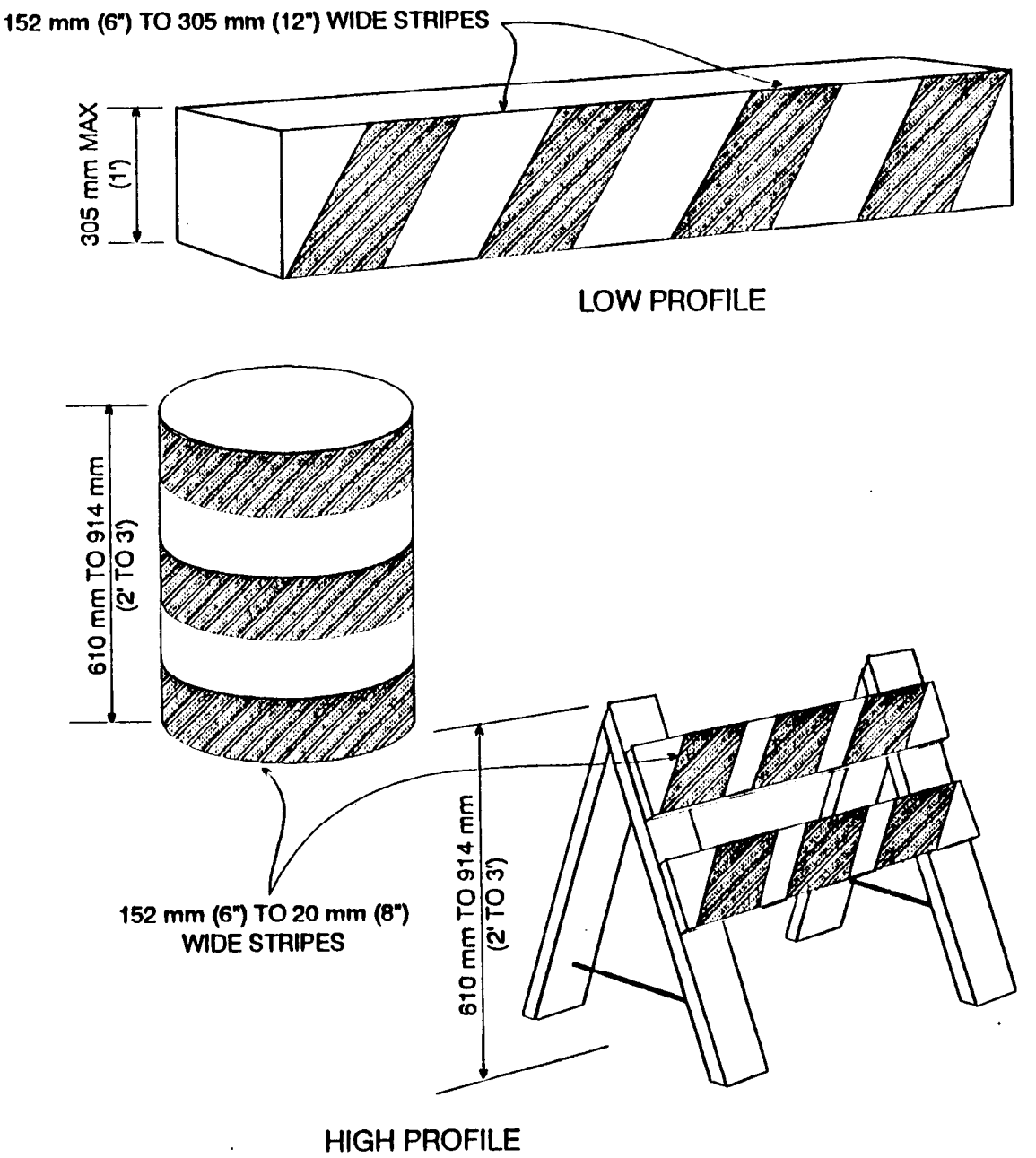
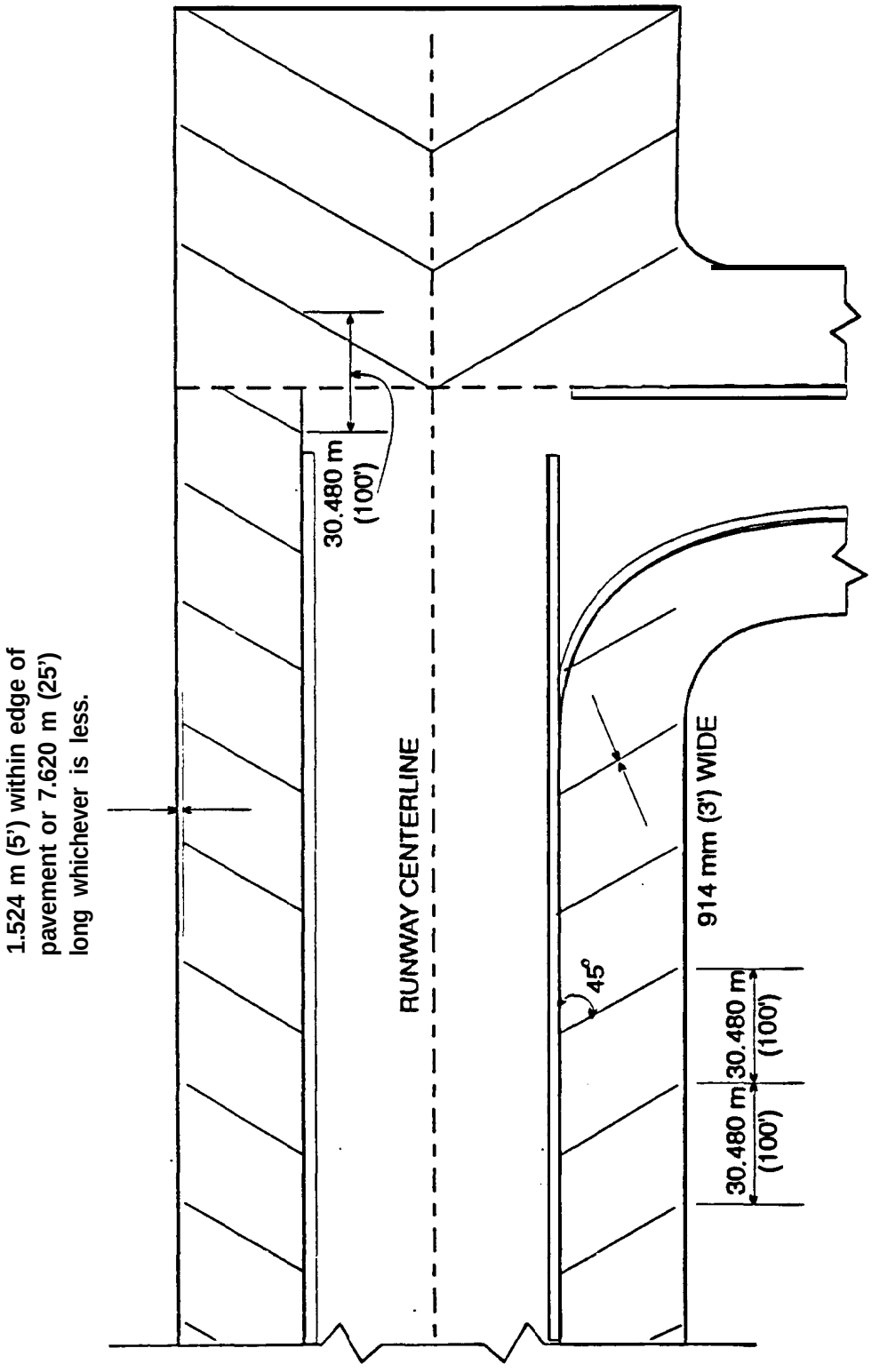


Figure 5.3. Barricades



5.4. Runway Shoulder Markings.

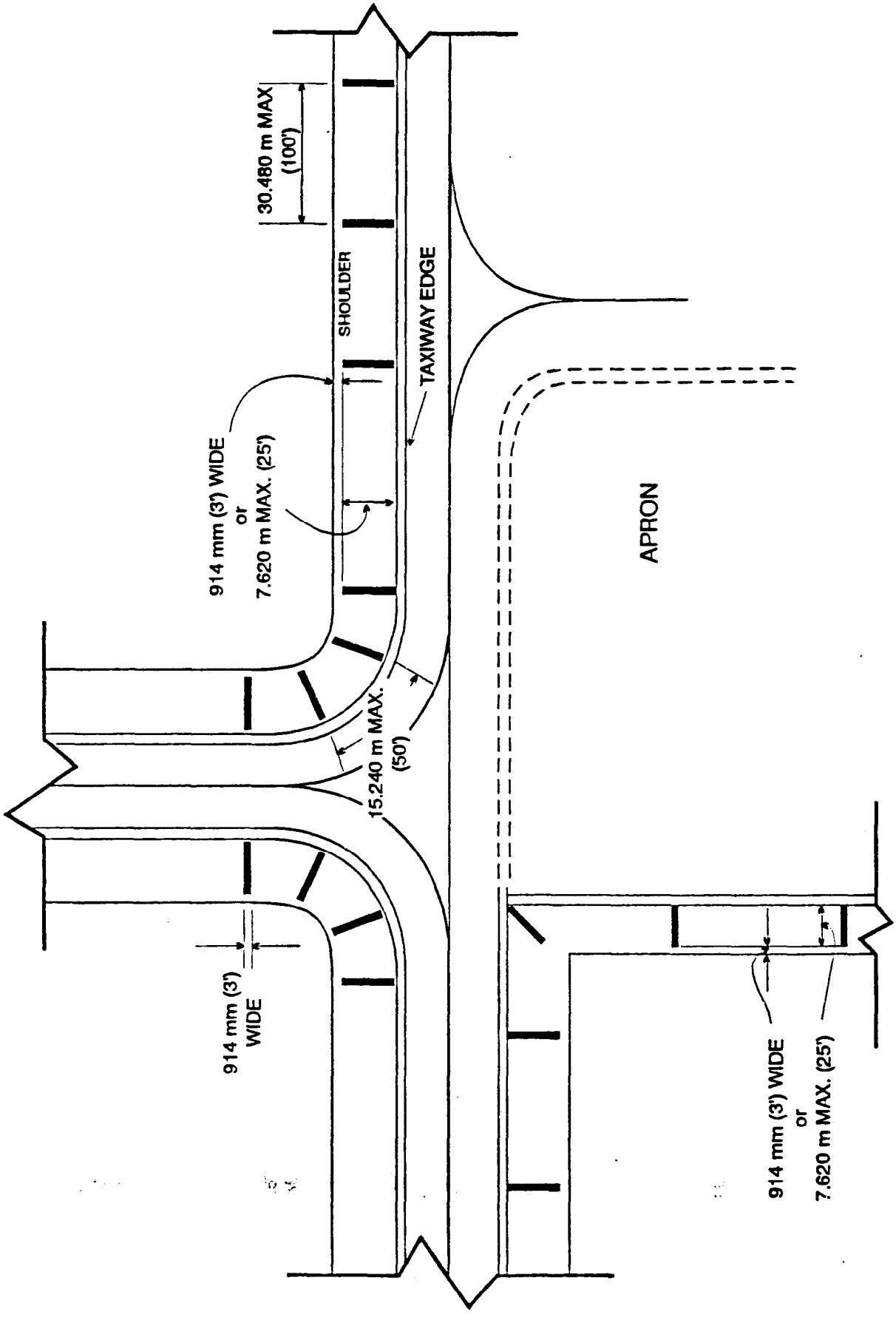
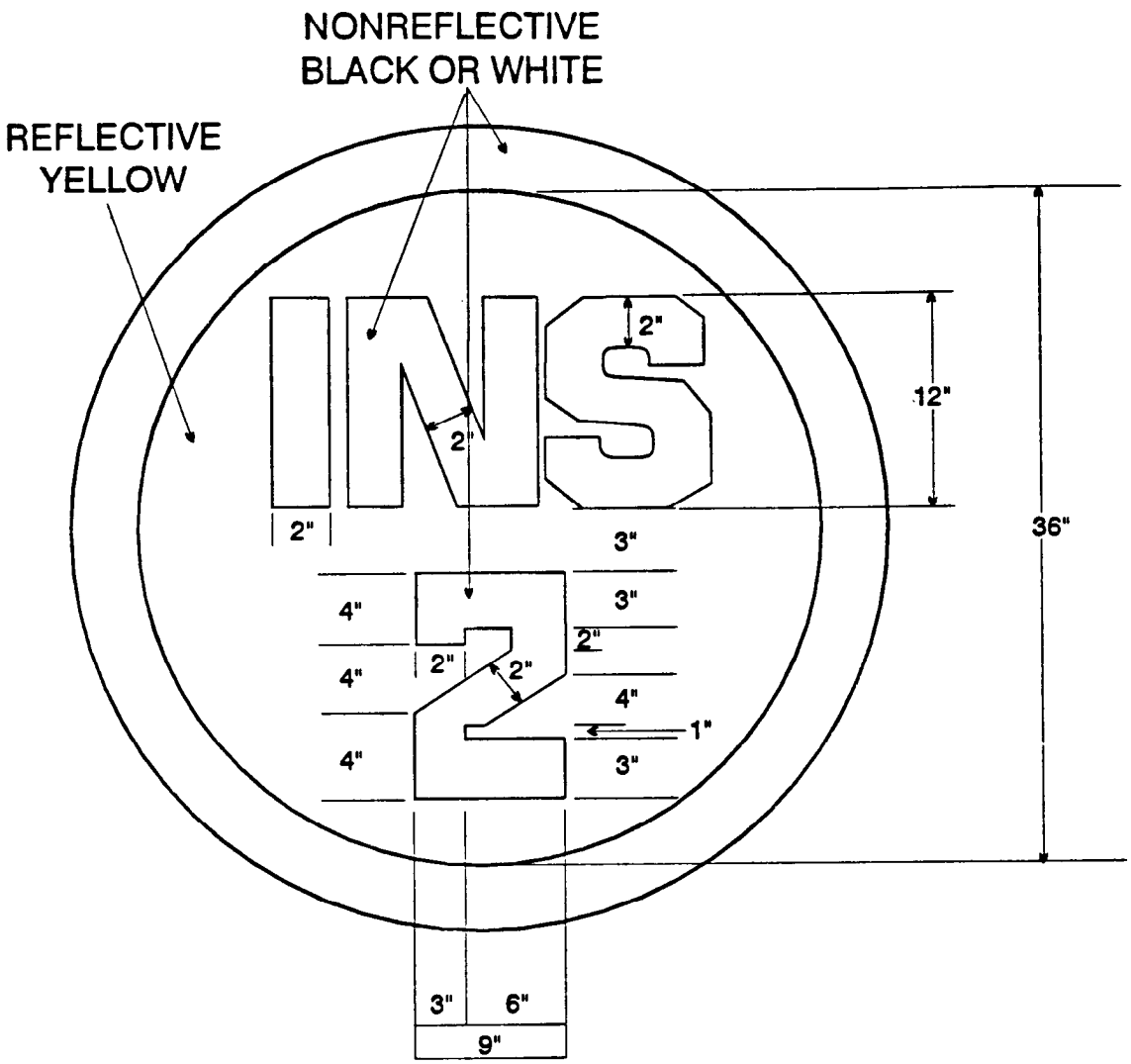


Figure 5.5. Taxiway and Apron Shoulders Markings (Deceptive Surfaces).



NOTE: To convert inches to millimeters multiply by 25.4.

Figure 5.6 Typical Inertial Navigation System Checkpoint Marking.

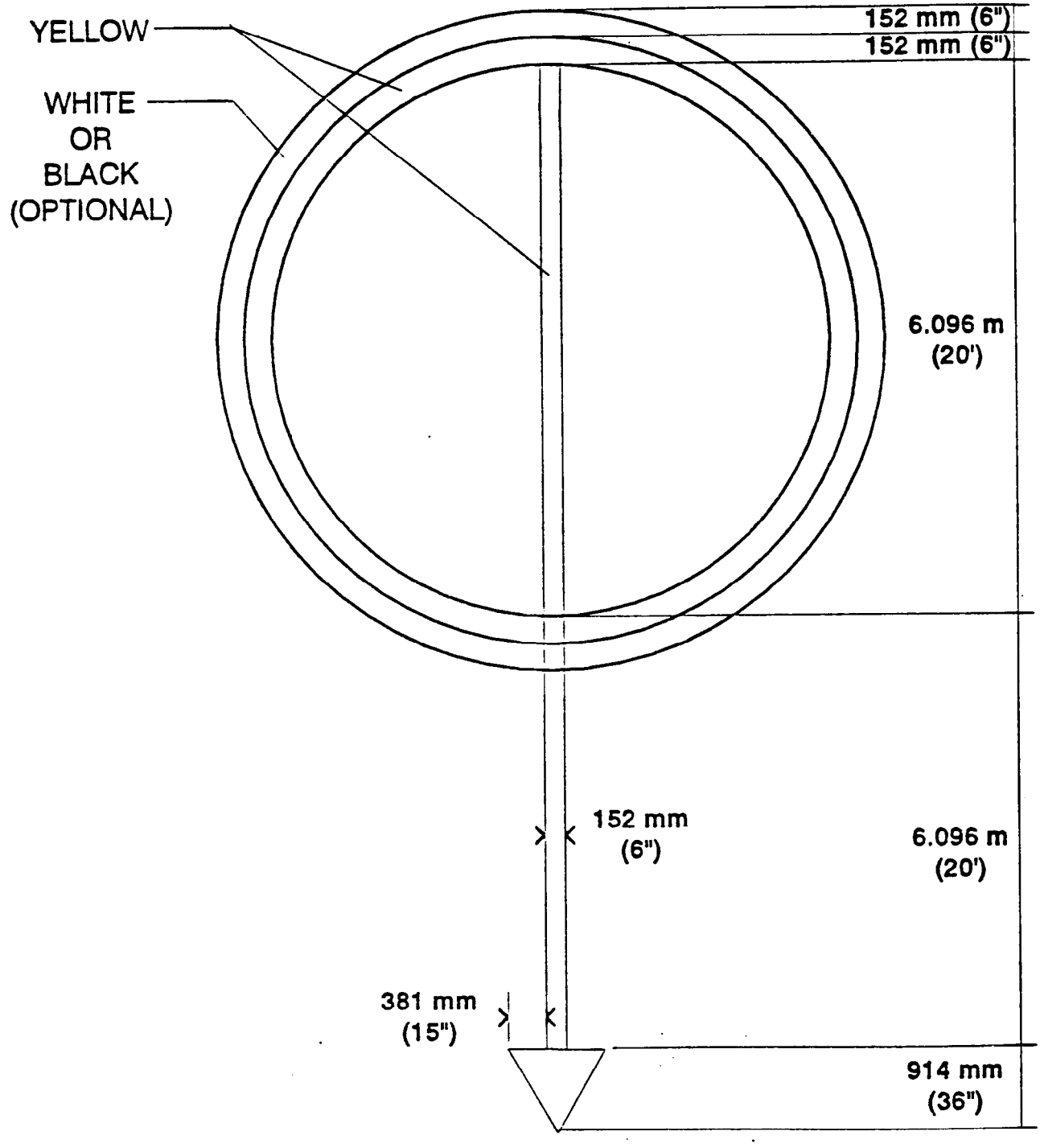


Figure 5.7. Ground Receiver Checkpoint (Directional).

6. Expedient Airfield Markings.

6.1. There are two basic types of expedient airfields--the shortfield airstrip or assault zone landing area, and the minimum operating strip (MOS). They are rapidly developed to support operations due to an urgent need, but support different types of operations. The shortfield (or assault zone) airstrip is developed to support airlift operations for aircraft such as the C-130 and the C-17, and the MOS is developed as a base recovery after attack effort to allow launch and recovery of fighter aircraft. The schemes for marking these type airfields are described below.

6.2. Shortfield or Assault Zone Markings. A shortfield or assault zone airfield is usually established in a forward operating location for airlift purposes. The runway or the entire operating surface may be constructed of dirt, sod, runway matting, or pavement. A combination of ground markings, portable lights, and edge markers may be used, but should be configured to define the runway, taxiways, and apron areas as shown in figure 6.1.

6.2.1. Runway Edge Markers. Obtain or construct fixed or portable edge markers which are unidirectional or bidirectional, as required. Each observed face must have a surface area of at least 372 mm^2 (4 square feet). They must be constructed in accordance with paragraph 1.2.2.2 and must not project more than 450 mm (18 inches) above ground level.

6.2.2. For training purposes, mark simulated shortfield or assault zone landing areas by painting six transverse stripes on the pavement. They should be 914 mm (3 feet) wide and extend from edge to edge of the runway. Mark two stripes to delineate a landing area at least 1,066.800 m (3,500 feet) long. Place an additional stripe 30.480 m (100 feet), and 152.400 m (500 feet) inboard from each end of the area.

6.2.3. Consult HQ AMC Regulation 55-60, Assault Zone Procedures, for further information.

6.3. Minimum Operating Strip (MOS) Markings. MOS markings consist of threshold and centerline pavement markings, edge markers, and aircraft arresting system location and Distance-To-Go (DTG) markers. Pavement markings and markers may be used together or independently. All components of the minimum operating strip marking system are shown in figure 6.2.

6.3.1. Pavement Markings. Where pavement markings are used, the threshold is marked with an inverted "T" formed with a 15.240 m (50 feet) long transverse stripe centered between the edges of the MOS at the designated beginning of the threshold. The centerline joins the transverse stripe at its midpoint and

extends 15.240 m (50 feet) toward the center of the MOS. Stripes may be solid or striated and form a marking which is at least 762 mm (30 inches), but not more than 914 mm (36 inches) wide. Centerline stripes and spaces are 15.240 m (50 feet) long. Note that the last centerline stripe may be up to 30.480 m (100 feet) long on strips which are laid out in even increments of 30.480 m (100 feet).

6.3.2. Edge and Threshold Markers. The MOS threshold is identified by placing ten markers adjacent to each other and perpendicular to the MOS centerline on each side of and in line with the threshold. Individual markers are placed 1.219 to 3.048 m (4 to 10 feet) from the edge of the MOS, and opposite each other on both sides of the MOS, at intervals not exceeding 60.960 m (200 sect). Each marker must have a viewed surface area of 372 mm (four square feet) minimum.

6.3.3. Distance To Go Markers. Where DTG markers are used for MOS applications, they are placed to be read on the right side of the runway only. Markers are placed a minimum of 304.800 m (1,000 feet) apart to indicate the distance remaining for a takeoff or landing. If the MOS is of odd length (uneven multiple of 304.800 m (1,000 feet), any distance remaining which is less than 304.800 m (1,000 feet) should be equally divided and added to the distance between the threshold and the first DTG marker. This means the DTG markers will always be coincident across the runway even though they are only viewed on the right side. Lateral placement will be a minimum of 7.620 m (25 feet) and a maximum of 15.240 m (50 feet) from the edge of the runway.

6.3.4. Aircraft Arresting System Markers. These warning markers are placed on both sides of the MOS in line with the DTG markers at each active aircraft arresting system cable crossing. They are positioned to be read on the right side of the MOS. If coincident with a DTG marker, they are placed 1.524 m (5 feet) outboard of the DTG marker.

6.4. Expedient Taxiway Markings. Where expedient taxiway markings are required, taxi lines are marked with a single 152 mm (6 inch) width continuous stripe. Unless there is a lack of contrast with the surrounding terrain, the stripe is only applied in critical areas such as curves and intersections. Holding positions on taxiways are marked with a transverse stripe a minimum of 762 mm (30 inches), but not more than 914 mm (36 inches) wide.

6.4.1. Where markers are required along taxiways, place them as close to the edges of taxiways as practicable, and equidistant laterally from its centerline. Intervals between such markers are not to exceed 67.056 m (220 feet) on straight taxiway sections and 36.576. m (120 feet) on curves. Markers are placed opposite each other on both sides of taxiway, excluding insides of curves where every other marker may be

omitted. At holding positions, double markers are provided on both sides of the taxiway.. Do not locate the outer markers more than 4.572 m (15 feet) laterally from the inner row of markers. Figure 6.1 shows a typical layout scheme for these markers.

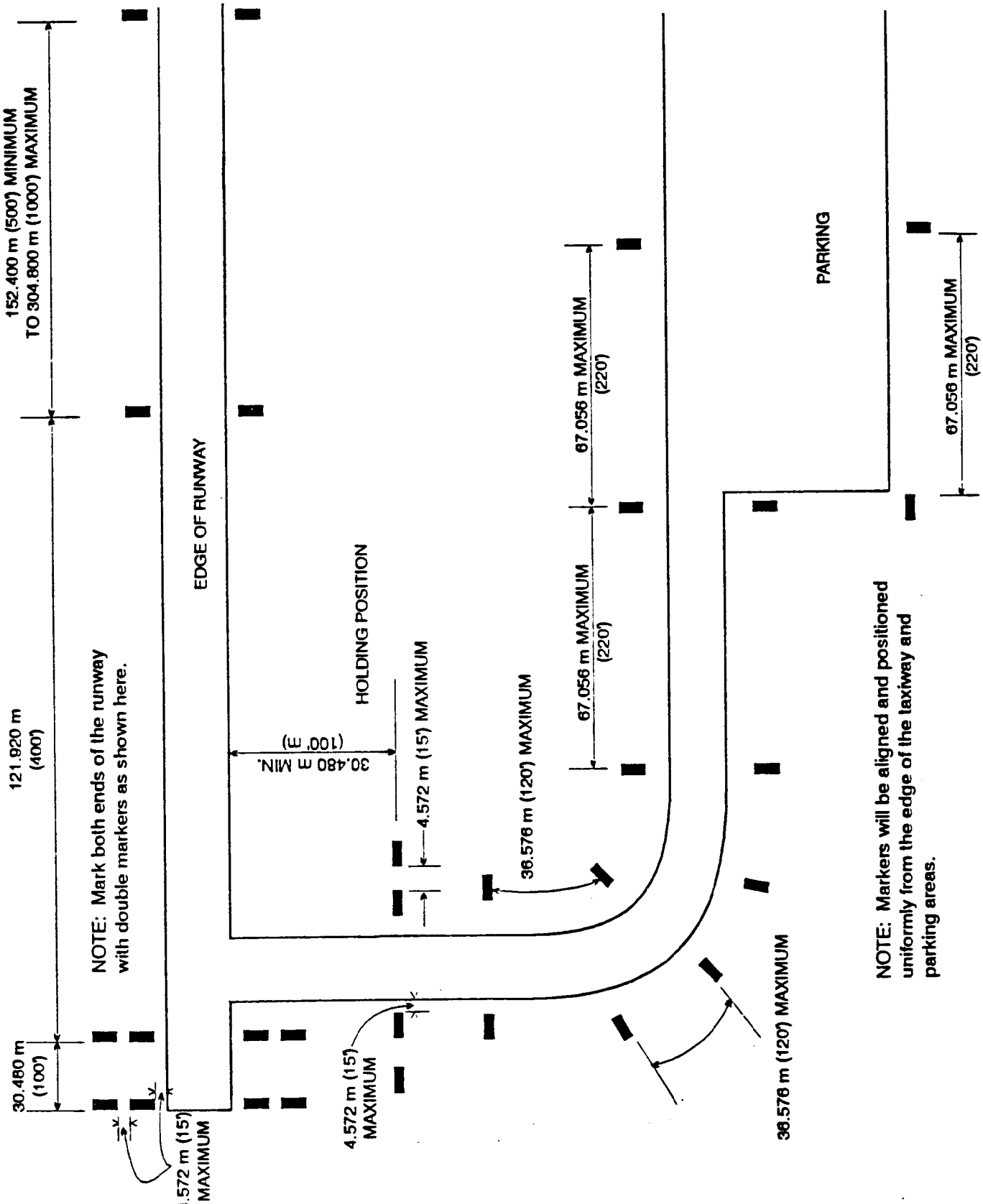


Figure 6.1. Typical Shortfield or Assault Zone Landing Area Markings.

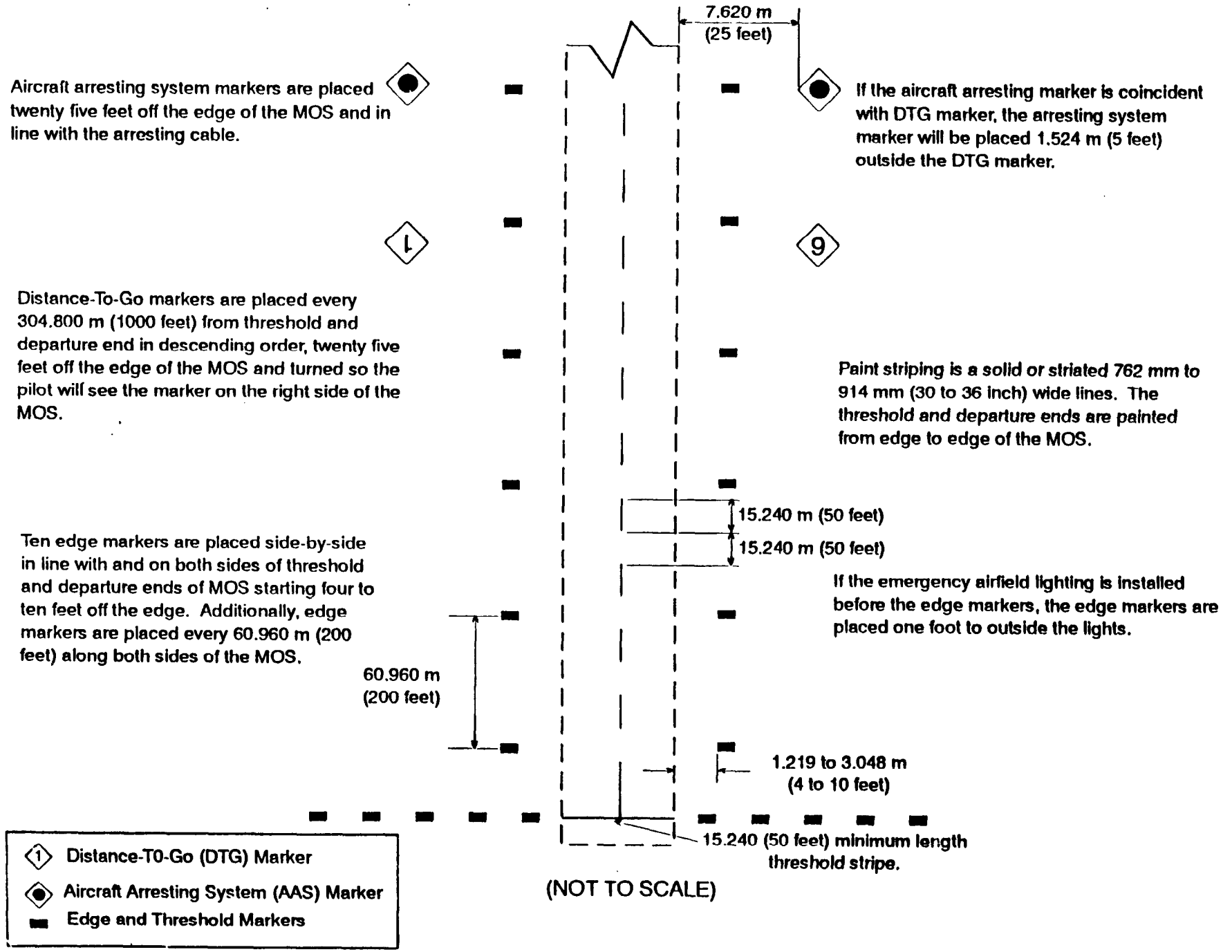


Figure 6.2. Minimum Operating Strip (MOS) Markings